

SCIENCE TEACHER'S WORLD

Teacher's edition of Science World • December 9, 1958

How to use free teaching aids

The science teacher who ignores free teaching aids from industry, Government, and elsewhere is "missing a trick." These materials offer many possibilities for use in teaching. Printed materials available today range from single-page charts to bound books. Illustrations often surpass those found in the most lavishly illustrated textbooks. For the most part, the content is fresh and up-to-date.

It's true that the accent, especially in industry-produced materials, is on applications rather than on fundamental principles. But principles are not entirely neglected. A stock brokerage firm (Atomic Associates, Inc.) puts out a periodic table of the elements in color. The emphasis is on those parts of the table that are pertinent to atomic energy. Chas. Pfizer & Co., Inc., offers a handsomely illustrated booklet that not only describes, step by step, the manufacture of penicillin, but also gives an historical sketch of the development of microbiology. (Since films and film strips will be covered in a future article on audio-visual aids, they will not be considered here.)

Who offers these materials?

Teachers can get free teaching materials from a wide variety of sources. These include:

- Manufacturers of automobiles, airplanes, electrical devices, optical instruments, building supplies, agricultural implements, chemicals, pharmaceuticals, etc.

- Companies engaged in mining, metallurgy, and oil refining.

- Companies that generate and distribute power.

- Broadcasting companies, airlines, railroads, and others that make up the communications and transportation industries.

- Trade associations such as the National Dairy Council, the National Live Stock and Meat Board, the Wheat Flour Institute, the Cereal Institute, the Association of American Railroads, and the Manufacturing Chemists Association.

- Governmental departments, agencies, and divisions, such as the U.S. Department of Defense, the U.S. Public Health Service, the Atomic Energy Commission, the Civil Aeronautics Administration, the Weather Bureau, the National Park Service, the Smithsonian Institution, and national and state conservation and other departments.

- Life insurance companies.

- Quasi-public organizations such as the American Red Cross, the National Audubon Society, the Better Vision Institute, and the National Safety Council.

Materials from industry

Large industrial firms have for decades produced pamphlets, charts, models, and even motion picture films for use by their sales force and by their public relations departments. The major purpose of such materials was to explain products to customers. But alert science teachers began to use them for another purpose: a source of enrichment for their teaching. Companies received more and more requests from science and other teachers for pamphlets, charts, etc. Farsighted company officials recognized this as a powerful potential for advertising and for building good will. They realized that material distributed to pupils finds its way to the home and that high school students eventually become potential customers. Some companies took steps, through their public relations departments, to

contact schools, offering teaching materials. Others went so far as to establish their own school-service departments.

As various companies climbed aboard the band wagon, competitors felt obliged to follow suit. In time, the teacher was faced with a bewildering array of pamphlets, charts, samples, film strips, and motion picture films. In the early days, much of this material, produced by company employees with well-developed commercial instincts, carried crude and blatant advertising that was objectionable to school men. Moreover, the printed materials were often far beyond the reading level of students. Teachers began to resist. It was at this point that the National Science Teachers Association stepped into the picture.

The NSTA took the initiative in bringing together representatives from industry and the schools. A Council on Science-Industry Relations was organized. It consisted of ten representatives each from industry and from education. Standards were established as a guide to industries planning the production of teaching materials. What is more, a panel of teacher-consultants to industry was set up to participate in the actual production of such materials. Out of the deliberations of the Council came mutual understanding of the twofold problem — industry's problem of production and distribution and education's problem of use in the classroom and of evaluation. As a result, there has been a steady improvement in these materials.

Some companies, through their school service departments, contact schools and teachers directly. At the beginning of the school year, Bristol-Myers Company sends to

health education teachers a whole package of materials on good grooming. Companies may announce their teaching materials in professional journals or in advertisements in other publications. The Upjohn Company, for example, recently mentioned in one of its advertisements that a copy of a booklet, "The Cell," would be sent to any teacher who requested it. Similar announcements appear as a regular feature in *SCIENCE WORLD*.

A classified and annotated list of available materials can be found in "Sources of Free and Inexpensive Materials." As a service to its members, the National Science Teachers Association regularly sends out a packet of recently produced materials useful in science teaching.

Some suggested uses

To supplement the textbook. This is the most obvious use of free materials. It may take ten years to write a textbook. So some of its content is bound to be out of date, even on publication. Moreover, a textbook must be comprehensive. Therefore, there are sheer physical limitations to the space that can be given to any one topic. Free teaching aids can help overcome these deficiencies.

To enliven bulletin board displays. In setting the "climate" for the study of a unit on atomic energy, it helps to have attractive pictures of atomic reactors, mechan-

ical manipulators, diagrams of atoms and of atomic power generators, and a photograph of an atomic explosion. A pupil often receives great satisfaction in carrying out an assignment such as this: "Cut out the pictures from this booklet and paste them up so that they tell the story in the booklet. Your finished product, if attractive, will be placed on the bulletin board when we study this topic."

To introduce a topic. A handsomely illustrated booklet on farm chemicals, put out by E. I. du Pont de Nemours and Company, has been used as a take-off point for the study of insects. A profusely illustrated seed catalogue has been used as an approach to the teaching of a lesson on plant breeding.

To illustrate applications of principles. A physics class that had just completed a unit on light was given a pamphlet called "Optics and Wheels" (General Motors Corporation). Using this booklet, the class not only reviewed the fundamental laws and theories of refraction and reflection, but also learned about specific applications that could be observed in the family car. Students who are studying blood and its circulation can be given the cleverly illustrated American Red Cross booklet, "The Story of Blood." This not only reviews some of the facts about blood studied in biology lessons, but also gives an appreciation of how these facts are used to save lives.

To help the exceptional student. The booklet "The Evolution of the Microscope" (American Optical Company) could be the basis for a fine special report to a biology class just learning to use the microscope. A student in general science who shows an interest in chemistry can make good use of a booklet "The Stuff Our World Is Made Of" (Westinghouse Electric Corporation). This booklet can open up to the student the world of chemistry and can provide him with some interesting projects to do.

To help the slow learner and poor reader. General Electric Company has put out some very fine science comic books that circulate in the millions. These can help the slow learner. And even a mediocre student in physics, if he has a flair

for art, can make enlarged charts of electronic tubes and circuits for the physics teacher by copying them out of the booklet, "The ABC of Electronics at Work" (Westinghouse).

To provide vocational guidance. What with the widespread shortage of engineers and technicians, industry is outdoing itself in the field of vocational guidance. One group — the Manufacturing Chemists Association — has an elaborate program to make available a wide variety of materials useful for acquainting students with opportunities in the field of chemistry. Research is a keynote in many of the materials developed by industry for use in the schools. Illustrations show people at work in field, shop, and laboratory. A free booklet "Short Stories of Science and Invention" (General Motors) puts emphasis not only on ideas but on the men and women who have produced them.

Any complaints?

Making free materials available to schools involves the expenditure of millions of dollars. What is the return on this investment? People in industry and government who shell out the money would certainly like to know. They wonder how much of the material that comes into the school is used poorly or not at all. They would like to know whether the material they are producing is what the teachers want and what the students need.

For their part, teachers often complain about some of this material. They point out that the illustrations are often superb, but the text is incomprehensible — or even irrelevant. Well, if you have complaints, make them known. Industrial people and heads of Governmental agencies will be grateful for your suggestions and criticisms. But these will be taken most seriously when they are based on your actual use of the materials with young people.

— ZACHARIAH SUBARSKY

(Note: Materials described in this article are used as illustrations only. Some are still available from the companies mentioned, but others have gone out of print.)

YOUNG SCIENTISTS

Teachers are urged to have their students submit write-ups of interesting projects or experiments they have done. If printed in *SCIENCE WORLD*, full credit will be given to the student, the school, and the teacher. In addition, the student will receive \$15. Contributions should be addressed to Science Project Editor, *Science World*, 575 Madison Avenue, New York 22, N.Y. Students should be reminded that by submitting their ideas they can do a service to thousands of other students.

MEMO

To: Science teachers

Subject: Ways to use this issue of **SCIENCE WORLD** in the classroom

Traits and traces

BIOLOGY TOPICS: biogeography, genetics, plant breeding, anthropology

Tracing the travels of prehistoric man by an examination of chromosomes in corn — what an intriguing application of cytology! Equally intriguing is the application of comparative studies of musical instruments, games, architecture, and embalming methods to uncover the wanderings of primitive man.

"Traits and Traces" can be used by the teacher to help dispel the notion that science and the humanities can be confined to separate compartments in the mind. The article will appeal equally to students whose major interest is either biology or social studies.

Review questions

1. In comparing primitive cultures of eastern Asia and western America, what similarities are found with respect to musical instruments, games, architecture, and mathematics? What two theories have been advanced to explain these similarities?

2. How did the idea originate that there had been a transfer of culture from the islands of the east Pacific Ocean to the western coast of South America?

3. What hypothesis did Thor Heyerdahl set out to test with his raft, *Kon-Tiki*?

4. In which part of the world did each of these originate: oranges, wheat, olives, potatoes, pineapples?

5. What evidence is there that even primitive man may have engaged in cross-breeding plants?

Inside Elmer

BIOLOGY TOPICS: nutrition, protozoa, bacteria, digestion, vitamins, biosynthesis, biological vocations

CHEMISTRY TOPIC: applications of biochemistry

The writer first met Elmer, the steer with the built-in porthole, in — of all places — the Grand Ballroom of the Waldorf-Astoria Hotel in New York City. Elmer was being exhibited there as part of a "lecture on antibiotics," put on by Chas. Pfizer & Co.

I was happy to meet Elmer again in this article. He and his farm friends should enliven the teaching of any of the topics listed above. Students may well be impressed with the variety of specialized areas

of science included in animal husbandry. There is much information here that is not in current high school biology textbooks. The article describes a number of investigations — from the origin of the problem, to the hypothesis, to the solution, to the application. It also points to several problems as yet unsolved. In short, the article can be used to teach science in an interesting, informative way.

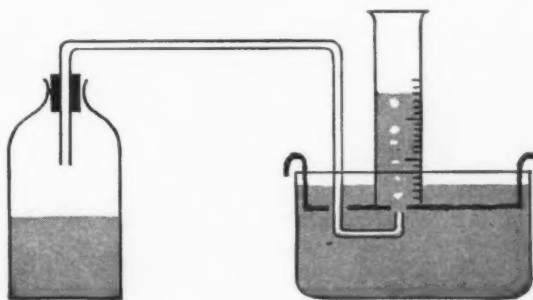
Student research

1. Look up in an advanced protozoology book some of the specific protozoa that live in a cow's rumen.

2. Look up in an advanced bacteriology book the bacteria that break down cellulose.

3. Gather information and write a report on one of the following: (a) tranquilizers, (b) vitamin B₁₂, (c) antibiotics, (d) amino acids.

4. Report on Dr. William Beaumont's early study of digestion in a wounded human and draw a parallel between that and the study of



IBM memo

The flexible, creative genius of Blaise Pascal was equally at home with abstract theory or workshop experimentation.

Before he was sixteen, he had completed a startlingly original study on geometric planes and curves. It proved to be a forerunner of our present projective geometry. Three years later, irked by the drudgery of adding endless columns of figures in his father's tax office, he translated his earlier abstractions into a design for the world's first successful calculator. Its principle of gear-driven counter wheels is still in use.

In 1648, Pascal announced his law on the behavior of fluids under pressure—a cornerstone of modern hydrodynamics. To demonstrate the principles, he built one of the world's first successful barometers.

A friend asked if games of chance might be governed less by luck than by laws of mathematics. Intrigued by this challenging idea, Pascal evolved a theory of probability upon which rest major elements of our present science of statistics—and, in turn, insurance mortality tables, and even business and military planning.

Finally, his intense interest in religion and the human spirit led Pascal to write his *Pensées*—still admired, three centuries later, for the acuteness of its reasoning and the polish of its prose.

Theorist and inventor . . . mathematician and scientist . . . philosopher and writer . . . Pascal knew that man's mind is too precious to be wasted on the burdensome tasks that a machine might do. Today, in business, science and industry, the machines of our time free man from the toil of endless calculation, complex beyond Pascal's wildest dreams.

In the Picture: The machine is an original calculator built by Pascal. It was designed to handle numbers and contemporary French currency. The machine is in the collection of the Arts and Sciences Department of IBM. The coins are 17th-century French.

International Business Machines Corporation,
590 Madison Ave., New York 22, N.Y.

(Advertisement)

Elmer's digestion through the port-hole.

(If you have a file of back issues, you will find the story of Dr. Beaumont's "human lab" in *SW* for December 17, 1957.)

Home project

To better understand the cause of bloat in animals, place half a teaspoon of molasses in half a glass of water, and crumble into this mixture half a teaspoon of yeast. Stir the mixture and pour it into a bottle that can be corked. (WARNING: Do not use a container with a screw-top cover.) Cork the bottle fairly tight, but not *too* tight. Let it stand in a warm place. In time, the cork will be blown out by the pressure of the carbon dioxide produced by the yeast. It is this kind of pressure that causes bloat.

School project

Fix a bottle as described above, but arrange for the carbon dioxide gas to be collected, as in the diagram. A study can be made of the effects of temperature or light on the amount of carbon dioxide produced. In this case, the yeast must be accurately weighed and the water and molasses measured. The inverted graduate (see diagram) indicates the amount of carbon dioxide produced.

Instead of repeating the experiment and varying the conditions, it might be a good idea to have two set-ups, one being experimental and the other serving as a control (e.g., one in a dark closet and the other in the light).

Smaller than the atom

PHYSICS, CHEMISTRY, AND GENERAL SCIENCE TOPICS: structure of the atom, evolution of our concept of the atom, atomic energy

Dr. Asimov has a talent for putting difficult scientific concepts into comprehensible English without misleading the reader through oversimplification. In Part I, he describes the structure of the atom, presenting, dynamically, a brief history of the model of the atom. Thus, for the student in a physics, chemistry, or general science class,

Part I constitutes an excellent review of what he may already have studied. At the same time, it lays the background for Part II, which will lead the student to consider further changes in the model of the atom brought about by more recent research findings. It may even lead him to peer into the most fascinating of realms — that of the unknown.

Review questions

1. Using Einstein's equation, $E=mc^2$, compare the amount of energy that can theoretically be obtained from the electron, the proton, and the alpha particle. (See a college physics text.)

2. Explain how paths of atomic particles are formed in a Wilson cloud chamber.

3. What observations led scientists to postulate the existence of a particle named the *neutrino*? How was the existence of this particle confirmed?

In the stratosphere

PHYSICS TOPICS: dispersion of light, Archimedes' principle, absorption and reflection of light, air pressure

CHEMISTRY TOPICS: acids, bases, and salts (reaction of carbon dioxide and alkali); metals (action of mercury on aluminum)

BIOLOGY TOPIC: respiration (breathing at high altitudes)

EARTH SCIENCE TOPIC: layers of the earth's atmosphere

This exciting article has many of the elements of an adventure story. Yet, not a word is fictitious. Nor does the spirit of adventure overshadow the spirit of science, as is evident from Piccard's closing words: "My aim is not to beat and above all not to maintain records, but to open a new domain to scientific research and to aerial navigation."

Science teachers will find the article useful as an introduction to or as an application of the topics listed above. It would be particularly appropriate to include in a science unit devoted to IGY or as background in a unit on space travel.

CEMBER 9, 1958

SCIENCE WORLD

THE SCIENCE MAGAZINE FOR HIGH SCHOOL STUDENTS

ent re-
y have
it lays
which
onsider
of the
ore re-
ay even
ost fas-
of the

on, $e=$
energy
btained
on, and
college

atomic
Wilson

l scien-
ce of a
? How
particle

of light,
absorp-
ght, air

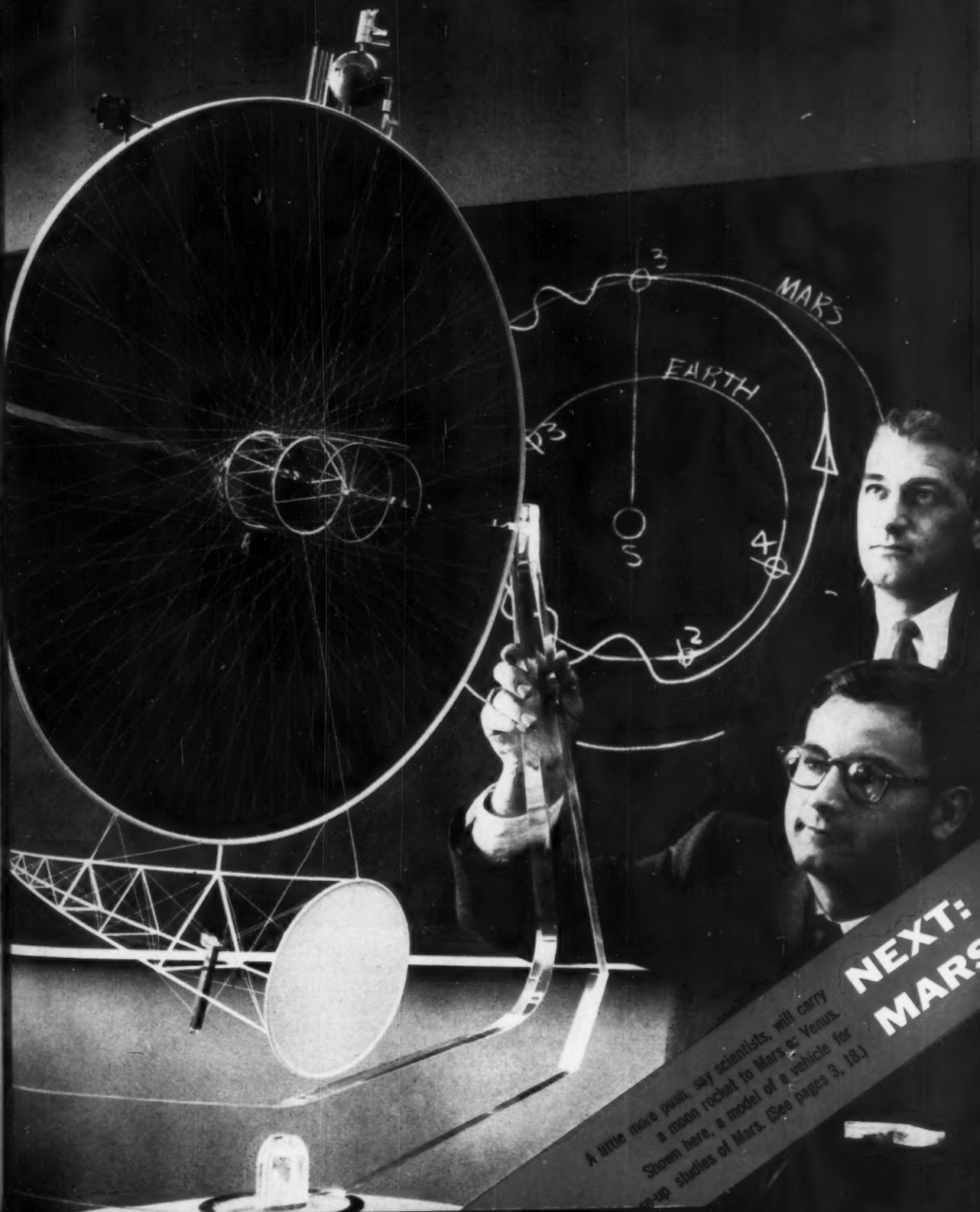
ses, and
dioxide
tion of

(breath-

s of the

many of
re story.
us. Nor
re over-
ce, as is
closing
eat and
records,
to scien-
naviga-

l the ar-
ction to
e topics
particu-
de in a
Y or as
n space



**NEXT:
MARS**

A little more push, say scientists, will carry
a moon rocket to Mars or Venus.
Shown here, a model of a vehicle for
space studies of Mars. (See pages 3, 18.)

AFTER GRADUATION BUILD FOR YOUR FUTURE CAREER IN THE U.S. AIR FORCE

Today, as a high school graduate, you face a great challenge. For yours is the Age of Space...the age of unlimited opportunity for the man with specialty training. Now, how can you best prepare for this important future? By training in the U.S. Air Force, where the Age of Space is *reality*. Here, Airmen work, day to day, in actual Space Age specialties: rocketry, guided missiles, supersonic aircraft, advanced electronics—and soon: manned flight into outer space. Nowhere else is so complete and broad a range of Space Age specialty training available to you as in the U.S. Air Force. Act now. See your local Air Force Recruiter, or mail the coupon below.



WHERE
THE
AGE OF SPACE
IS
REALITY

THE FUTURE BELONGS
TO THE AIRMAN

PASTE COUPON ON POSTAL CARD AND MAIL TO:

Airman Information, Dept. SW-13321
Box 7608, Washington 4, D. C.

Please send me information on my opportunities in the U.S. Air Force. I am between the ages of 17-34 and reside in U.S.A. or possessions.

Name _____

Address _____

City _____ Zone _____ State _____

SCIENCE WORLD

THE SCIENCE MAGAZINE FOR HIGH SCHOOL STUDENTS

The Staff

Editor-in-Chief: Patricia G. Lauber
Managing Editor: Roger G. Menges
Art Director: Murray J. Miller
Copy Editor: Marguerite S. Hecking
Library/Research: Harriet E. Rosenfeld
Assistant Editor: Jane Rockwell
Editorial Assistants: Julio E. Xavier, Zelda Gilbert
Consulting Editor: Dr. Morris Meister,
 Past Principal and Founder, Bronx High School of Science
Contributing Editors
SCIENCE WORLD:
 Edmund H. Harvey Jr.
SCIENCE TEACHER'S WORLD:
 Dr. Alexander Joseph, Bronx High School of Science
 Dr. Zachariah Subarsky, Bronx High School of Science

Street & Smith Publications, Inc.
 Also publishers of Mademoiselle, Living for Young Homemakers,
 Charm, Astounding Science Fiction, American Modeler,
 Air Progress, Air Trails Model Annual
President: Arthur Z. Gray
Executive Assistant to the President: Irma Pezzis Haubold
Executive Vice-President: Ralph R. Whittaker Jr.
Vice-President and Advertising Director: Robert E. Park
Treasurer: Thomas H. Kaiser
Director of Sales Development: Edward M. McGlynn
Advertising Manager: Ernest E. Pascucci
 575 Madison Ave., New York 22, N. Y.
Western Manager: Glover M. Young
 230 N. Michigan Ave., Chicago 1, Ill.
Los Angeles Representative: Whaley-Simpson Co.
 6608 Selma Ave., Los Angeles 28, Calif.
San Francisco Representative: Whaley-Simpson Co.
 700 Montgomery St., San Francisco, Calif.
Publication Office: 575 Madison Avenue, New York 22, N. Y.

Science World Advisory Board

Saul Geffner, Forest Hills (N.Y.) High School
 Alan Humphreys, Division of Extension, The University of Texas
 Dr. Alexander Joseph, Bronx (N.Y.) High School of Science
 Dr. Morris Meister, President, Bronx Community College
 Dr. Ellsworth S. Obourn, Specialist for Science,
 U.S. Office of Education
 Dr. Randall M. Whaley, National Academy of Sciences
 John A. Behnke, Ronald Press
 Dr. Gerald Wendt, noted science writer and lecturer
 Dr. Carl R. Addinall, Merck Sharp & Dohme
 Bruce MacKenzie, International Business Machines Corporation
 Harold S. Renne, Bell Telephone Laboratories, Inc.
 Dwight Van Avery, General Electric Company
 Dr. Elliott R. Weyer, Chas. Pfizer & Co., Inc.

Coming in SW December 23

Science has made many great gifts to peace.
 How many of them can you name?
 The electron, neutron, proton, and neutrino marked only the beginning of the discovery of sub-atomic particles. How many others can you name?
 What legacy was left to modern chemistry by the alchemists?
 Why do meteorologists watch clouds?

For answers, see next issue of *SW*.

Contents • December 9, 1958 • Vol. 4 • No. 6

Features

- 4 Inside Elmer, by Lois Hoffman
- 8 Smaller Than the Atom, by Isaac Asimov
- 11 Traits and Traces, by Lynn Poole
- 14 In the Stratosphere (Conclusion),
by Auguste Piccard

Stranger Than Fiction

- 24 The Case of the Silent Howlers (Conclusion),
by Murray Morgan

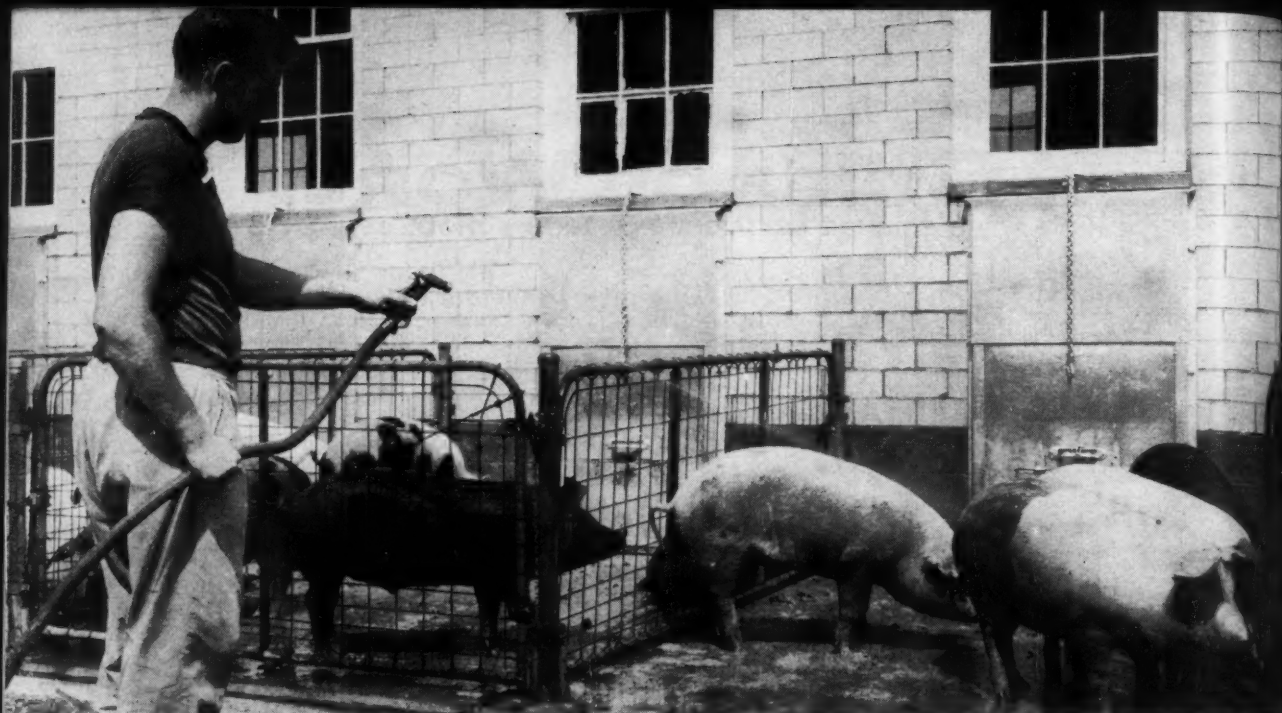
Departments

- 18 Science in the News
- 20 Young Scientists: Two Springboards
to Projects, by Theodore Benjamin
- 22 Question Box
- 26 Yours for the Asking
- 27 On the Light Side, by George Groth

Cover photo courtesy Boeing Airplane Company

Cover story

As the United States moves closer and closer to a successful moon probe, scientists are looking ahead to a probe of Mars or Venus, for we already have the rocket power to reach them. Shown on *SW*'s front cover this issue is a still further look ahead: a 1/20 scale model of a basic design for a vehicle that could make close-up studies of Mars. Full-size, it would be about 40 feet in diameter and weigh 600 pounds. It would be assembled and launched from a satellite station at least 400 miles above Earth. Taking power from the sun and propelled by a continuous low thrust from an ion accelerator, the unmanned disk-shaped explorer would take about three years to orbit Mars and return to its satellite launching place. Images received by its tracking telescope and observed by a television camera would be transmitted optically to Earth, while a mass of recording instruments would be guided by other scientific observations. The vehicle was designed by the two Boeing scientists shown with it, Richard D. White (rear) and Henry K. Hebel.



PAMPERED PORKERS on experimental farm live under hospital-like conditions. Records are kept of each animal's weight gains, growth, sickness, etc. During experiments on nutrition, each animal receives exactly the same feed, water, care.



FAT-METER measures the amount of fat in a hog. Scientists are developing animals that have less fat and more meat.



PORTHOLE IN ELMER'S side enables scientist to extract materials from stomach for study. Hole doesn't bother steer.

By Lois Hoffman

INSIDE ELMER

By studying what goes on in a steer's four stomachs,
scientists are finding ways of making animals grow faster and healthier
— which means more meat for more people

■ The star boarder of a 700-acre experimental "farm" near Terre Haute, Indiana, is a steer named Elmer. Elmer's eminence is the result of a lucite-and-stainless-steel porthole in his side. The porthole, which doesn't bother Elmer a bit, was put there by nutrition researchers who are investigating what happens to food eaten by animals. Their purpose is to find ways in which farmers can produce meat more efficiently. Throughout the country, many other scientists are working toward the same purpose.

The farm where Elmer lives is operated by Chas. Pfizer & Co., Inc., one of the world's largest producers of antibiotics and other pharmaceuticals. Researchers there use Elmer's porthole to investigate the workings of the rumen. This is the first of four stomach chambers through which food passes in cattle, sheep, goats, and other ruminants.

You and I would starve on a grass diet — but not Elmer. The fluid in his rumen contains billions of bacteria and protozoa. These micro-organisms produce enzymes that digest grass and hay, turning them into fatty acids, proteins, B vitamins, and other nutritive substances. The only way human beings can get these nutrients is by eating foods that contain them. But Elmer can make his own from low-grade plant material, thanks to the micro-organisms in his rumen.

A look through the porthole shows that this process is, as one

Pfizer researcher puts it, "just about the most seething metabolic activity imaginable." The rumen and the second stomach chamber, the reticulum, form a living fermentation tank with a capacity of some sixty to seventy gallons. This tank churns the food back and forth and finally pushes it into the third chamber, the omasum. This chamber apparently does nothing more than squeeze out some of the liquid. Not until the food reaches the fourth chamber, the abomasum, is it ready to be acted on by gastric juice and sent out into the blood stream.

Even with the help of their special micro-organisms, ruminants aren't so efficient as other farm animals in turning feed into meat. On the average, a pig gains a pound for every three and a half pounds it eats. But, usually, at least ten pounds of feed are needed to put a pound on a steer. Since Americans seem to like beef better than any other kind of meat, farmers are naturally interested in learning ways to make beef steers (as well as other farm animals) gain more weight on less feed. At agricultural research centers like the one at Terre Haute, animal nutritionists, veterinarians, pharmacists, bacteriologists, and other specialists are turning up new weight-producing feed supplements. Leaving Elmer for a minute, let's see how the Terre Haute project got started.

At about the same time in the late 1940's, researchers working in-

dependently in several parts of the country accidentally made an important discovery. They were feeding various forms of vitamin B₁₂ to poultry as a growth stimulant. The scientists noticed that poultry fed with the crude form of the vitamin grew faster than poultry on a refined B₁₂ diet. Why? Laboratory analysis showed that the crude form contained one important extra ingredient: a very small amount of an antibiotic.

The Pfizer company seized on this discovery and, in 1952, set up the Terre Haute farm to find the types and dosages of antibiotics that would produce the best results in various animal species. Pfizer scientists demonstrated that minute amounts of antibiotics (without the B₁₂) could produce spectacular weight gains in poultry and livestock alike. For instance, it normally takes fourteen to sixteen weeks and fifteen pounds of feed to raise a three-pound broiler. But when given antibiotic-supplemented feed, a chick would reach a three-pound weight in eight or nine weeks on just half as much feed. The chicken was apt to be healthier than average, too.

No one knows just why antibiotics make animals gain weight faster. "But," says Dr. H. G. Luther, director of Pfizer's Agricultural Research and Development Center, "it's probably because the antibiotic kills off some of the disease 'germs' normally present in

the animal's intestinal tract. When the animal doesn't have to fight these organisms, it can put all its strength into growing faster.

"Understand, in these feeding trials we don't give nearly enough antibiotic to act as a medicine. For example, we've found we can get good results by adding less than one-third of an ounce of antibiotic to a ton of chicken feed."

Antibiotics have some curious, unexplained secondary effects when fed to chickens: they make the birds lay more than fifty extra eggs a year. And the eggs of chickens on an antibiotic-supplemented diet have unusually tough shells, so there's less breakage in shipping and handling.

Feeding antibiotics to beef steers poses a special problem. These chemicals could destroy the micro-organisms that help digest the food the steers eat. Here's where Elmer makes a contribution in the testing of possible feed supplements.

From the porthole in his side, the Pfizer scientists draw out a sample of rumen fluid. This sample goes to the laboratory. Its micro-organisms are kept alive and kicking in an apparatus of plastic hose and test tubes that's called an artificial rumen, or mechanical cow. To duplicate the conditions normally found

in a living cow's stomach, the temperature inside this artificial rumen is kept at 39.5° C. (130° F.). Also, a constant stream of carbon dioxide (one of the by-products of fermentation) is bubbled through the tubes. When the researchers add an antibiotic or some other test substance, they can watch what happens and take samples as needed. (At the beginning stage, this is a much cheaper, faster, and more precise experimental method than tests on living animals.)

Depending on what test substance is added, the rumen "bugs" may speed up, slow down, or completely stop their work of digesting cellulose. When an antibiotic is included in their feed, they usually slow down the first day. But by the second or third day, the micro-organisms are apt to be working faster than ever before. Observing such a reaction, the research workers know that the substance being tested won't be harmful. They can safely run experiments with it in living animals.

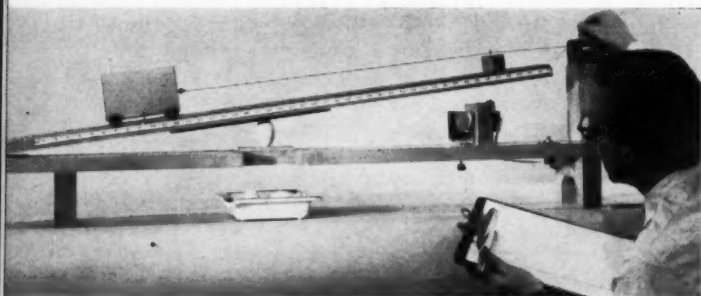
Generally, antibiotics make steers gain weight 11 per cent faster than normal. Antibiotics plus a synthetic hormone, diethyl stilbestrol, sent the growth bonus up to about 23 per cent. These growth stimulants don't change the composition of

the meat in any way. It tastes just as good and is as safe to eat as the meat of an animal on a regular diet.

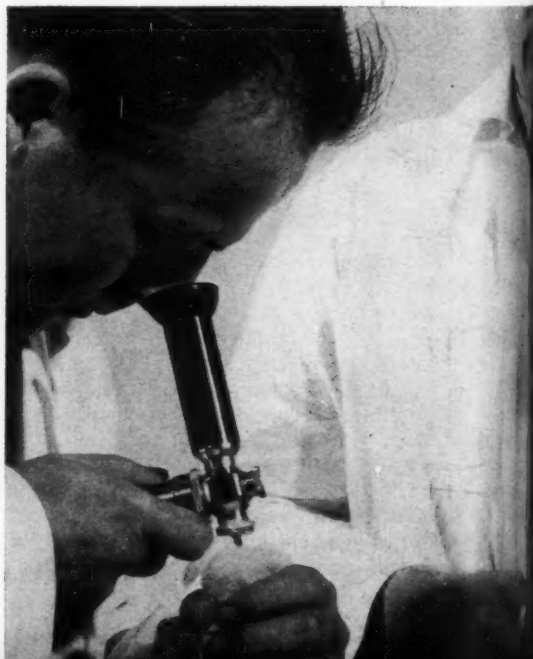
The steer's weight can safely be boosted still further with a tranquilizer. This was discovered accidentally, a couple of years ago, during research on the use of tranquilizers to calm down nervous or bad-tempered animals. The dosage necessary simply to promote growth is only a fraction of that used, for example, to insure the good behavior of the horses that pulled Queen Elizabeth's carriage when she visited Williamsburg, Virginia, in 1957. Only 25 cents' worth of tranquilizer may add a further 12 per cent weight increase to the 23 per cent rate obtained by giving steers antibiotics and hormones.

Once more, scientists are in the dark as to the reasons for this weight-boosting effect. So little tranquilizer is given that the steer's behavior and activity aren't affected at all. (One heaping tablespoon of this material in their feed is enough to promote growth in 100 steers for 100 days.) But scientists think he is more contented (subconsciously) and can therefore digest food better.

Whether tranquilized or not, the experimental farm's 7,000-odd hogs,



EGG-SMASHER is an ingenious machine for measuring strength of eggshells. It has demonstrated that shells of eggs laid by hens on antibiotic rations are about 20 per cent stronger than those from hens on normal diets. Right: Chicks to be used in feeding trials are examined by technicians. It has been found that antibiotics make a chick put on weight much faster.



lambs, steers, sheep, turkeys, game birds, chickens, and other animals scarcely know what discomfort means. In fact, they get better care and live in cleaner quarters than many human beings. A new aluminum and concrete shed, almost a quarter of a mile long, houses 1,000 sheep and 1,000 cattle. In another building, sows with newborn piglets have special maternity rooms, complete with tiled baths.

The researchers prefer to use test animals that have been born or hatched in similar environments. Only in this way can they make sure that some animals out of a group haven't been exposed to disease or other factors that might throw the experimental picture out of focus. During a test, each animal must be given as much space, light, heat, air conditioning, food, and water as his neighbor. Otherwise, it would be difficult to track down the cause of variations in the animal's growth and general well-being.

These pampered beasts are watched over by a staff of some thirty scientists and by sixty farm workers who are expert at everything from wrestling a one-ton steer onto a scale to bottle-feeding an orphaned lamb. Each animal has a number, if not a name. Poultry are identified by metal wing bands,

pigs by ear notches, steers by numbered tags on neck chains. IBM cards keep track of each animal's weight gains, growth, health record, etc. During the course of some experiments, animals may have to be given blood analyses and other laboratory tests every few hours.

In addition to being used in experiments on nutrition and feeding, some of these animals help the scientists develop ways to cure or prevent common farmyard diseases. Here's one example:

As mentioned earlier, carbon dioxide is one of the by-products of fermentation. Normally, the cow gets rid of this by belching. But with a condition called "bloat" the cow stops belching, and its stomach swells up. It dies within a few hours unless relieved somehow.

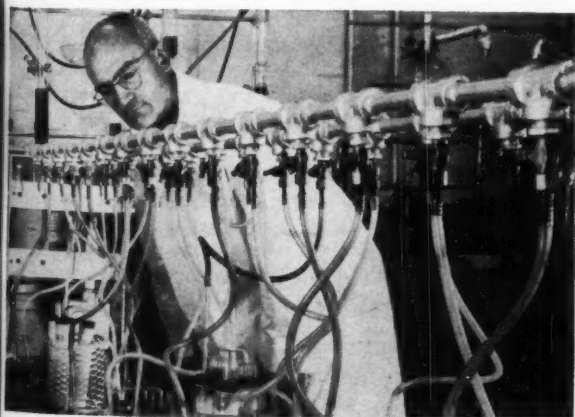
When researchers started observing the cow's digestive process through a porthole, they discovered the cause of bloat: occasionally, during the fermentation process, certain substances in the cow's fodder produce a foam. This traps the carbon dioxide so the cow can't get rid of it. By preventing the formation of this foam, the antibiotics have once again proved their usefulness on the farm.

All over the country, at university, government, and industrial ex-

periment stations like the one near Terre Haute, the search for new and better ways to grow larger, healthier animals goes on. The veterinary profession and commercial producers of poultry and livestock also co-operate. Finally, after many tests have shown what amounts of proven feed supplements give best results, commercial feed companies start incorporating these supplements into their products as a regular thing.

Says Dr. Luther, "In his feed, the modern farm animal gets such extra ingredients as vitamins, antibiotics, minerals, amino acids, unidentified growth factors, enzymes, pigments, flavoring materials, and so on. Each of these additives may require special handling so that none of its effectiveness is lost. Mixing feed today is a job for a real expert.

"Though we already have all those valuable additives, we're still looking for more. Predictions are that before today's babies reach college age, the population of this country will have increased by 50 million, to a total of 225 million. If we don't find ways to produce food more efficiently, where are the steak, roast pork, and fried chicken to feed all those people going to come from?"



MECHANICAL COW — a maze of pipes and glass tubing — duplicates work of the rumen, cow's first stomach. Scientists use the device to study effects of various nutrients on micro-organisms found in the rumen's fluid. **Right:** Scientists on the farm are producing faster-growing and healthier animals. As a result, price of pork chops today is 87 cents a pound rather than \$1.77.

Smaller than the atom

The atom was once thought to be the smallest piece of matter.

Then three smaller pieces were found within the atom.

Using these, scientists drew up a neat atomic model, but this, too, was soon outdated. Part 1

By Isaac Asimov

■ Just as the nineteenth century was closing, scientists realized that the tiny atoms were composed of still tinier sub-atomic particles. This upset some of their calmest certainties. For a century, they had felt sure that nothing smaller than atoms could exist. This discovery forced them into a new and deeper understanding of the laws of nature. A tremendous scientific advance followed.

Electrons, protons, and neutrons

It was in 1897 that the first sub-atomic particle was definitely recognized by the British physicist Sir Joseph John Thomson. It was called the *electron* because it was the basic unit of electricity. The electron was found to be a tiny thing, less than a thousandth of the weight of even the smallest atom.

All electrons were found to carry a type of electric charge that physicists had been calling negative for a hundred years. Now, ordinary atoms, scientists knew, did not carry an electric charge. They were neutral. Yet, all atoms could be made to lose an electron. When

this happened, what was left of the atom carried a charge of the opposite type, one that was "positive."

Scientists were reasonably certain, therefore, that somewhere within the atom there must be a second kind of particle — a kind carrying a positive charge. It was not until 1914, however, that the positively charged companion-particle of the electron was detected by the British scientist Sir Ernest Rutherford. Its positive charge was exactly as great as the negative charge on the electron. The charge on the electron was set at -1 ; so the charge on the new particle, called the *proton*, was $+1$.

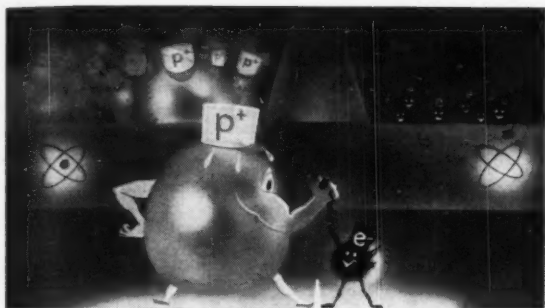
However, it turned out that the two particles were different in another way. The proton was by far the more massive of the two. It was as massive as 1,836 electrons. This, somehow, made the proton seem the more important of the two — first in line, so to speak. That is how it got its name. *Proton* comes from a Greek word meaning "first."

Scientists detected and studied these two sub-atomic particles by their "trails." When these particles

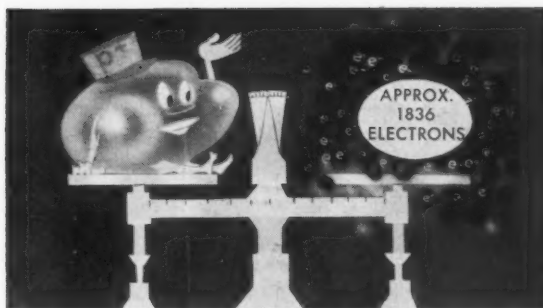
were ejected from atoms, they achieved enormous speeds. They smashed other atoms that got in their way. Under the proper conditions — for example, in a Wilson cloud chamber — these smashed atoms could be made to collect droplets of water about themselves. The result was that individual protons and electrons left trails of water droplets behind them. From these trails scientists learned a great deal, just as skilled hunters tell much from the footprints of the game they track.

It was because the proton and electron were charged, however, that they did so much damage. If there were a neutral particle — one that did not carry an electric charge — it would creep quietly through matter, the scientists reasoned. It would leave no easy trail by which it could be detected. Such a neutral particle does exist. But it wasn't until 1932 that it was discovered by the English scientist James C. Chadwick. This neutral particle was named the *neutron*.

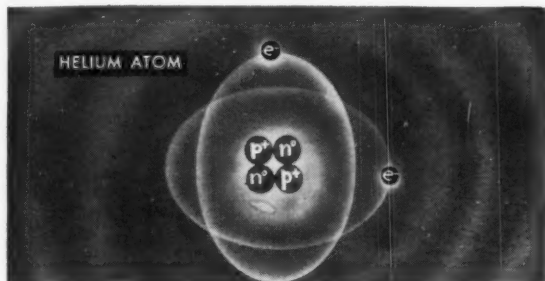
The neutron was found to be a massive particle, like the proton.



THOUGH MORE MASSIVE than an electron, a proton has an electrical charge equal to (but opposite from) the electron's.



POSITIVELY CHARGED PROTON has the same weight (more accurately, mass) as 1,836 negatively charged electrons.



THIRD FAMILIAR PARTICLE of the atom is the neutron. Neutrons and protons are bound together to form the nucleus.



FREED FROM THE ATOM, a neutron has a life of up to eighteen minutes, then decays into a proton and an electron.

In fact, it was just a trifle more massive. Where a proton was equal in mass to 1,836 electrons, a neutron matched the mass of 1,837 electrons.

By using these three particles, it was possible to build up a very neat picture of the atom to replace the hard, smooth, billiard-ball atom of the nineteenth century.

The 1932 model of the atom was one made up of neutrons and protons squeezed into the very center of the atom to form the *atomic nucleus*. (For this reason, when protons and neutrons were lumped together, they were called *nucleons*.) The light electrons filled the outer portions of the atom. Scientists might have been content to stick with this model, for it explained a great deal. But it was soon to become outdated.

'Frozen energy'

Now, of course, the three particles are tiny pieces of matter. But that is not all they are. Matter can be converted to energy. So each particle is not only a piece of matter, but also a piece of "frozen

energy," so to speak. The more massive a particle is, the more energy it represents. The proton, for instance, can be converted into 1,836 times as much energy as an electron can.

The practical proof that matter can be converted to energy came with the discovery and subsequent investigation of radioactivity. In 1896, the French scientist Henri Becquerel found that uranium ore was constantly giving off energy in the form of radiations of a type previously unknown. Uranium has a very complex atom, and soon other elements with complex atoms, such as radium, were found to behave similarly.

Sir Ernest Rutherford discovered that the radiations consisted of *alpha rays*, *beta rays*, and *gamma rays*, which were named after the first three letters of the Greek alphabet. It was eventually found that the gamma rays were pure energy. They resembled X rays in their properties, but were even more energetic.

Alpha rays and beta rays, on the other hand, were found to consist

of streams of speeding particles. The particles of the beta rays (*beta particles*) were speeding electrons. The *alpha* particles, however, were more complex. They were not single particles but combinations of four particles — two protons and two neutrons.

Alpha particles and beta particles result from rearrangements and changes within the atomic nucleus. Every once in a while, the nucleus of a radium atom, or of certain other atoms, rearranges itself into a more stable form. In doing so, it expels an alpha particle with great energy. This energy shows itself in the great speed of the ejected particle, which may be traveling at velocities of about 10,000 to 186,000 miles per second. Moreover, additional energy is often given off in the form of gamma rays.

But where does all this energy come from? It originates from some of the mass of the atomic nucleus that is rearranged. Each time an individual atomic nucleus rearranges itself and emits an alpha particle, a beta particle, or a gam-

ma ray, a tiny quantity of its original mass disappears and then reappears in the form of energy. The exact amount of mass that has to be used to form a particular amount of energy is expressed in Albert Einstein's famous equation: $e = mc^2$ (where e represents energy, m is mass, and c is the speed of light).

Using this equation, scientists balanced the books neatly in many radioactive transformations. When so much mass disappeared, so much energy appeared. Check and double-check.

A 'speeding nothing'

Unfortunately, the computations didn't always work. Alpha particles and gamma rays gave no trouble. But when beta particles were being formed, the books generally did not balance. The beta particles did not move rapidly enough; they did not contain enough energy to account for all the atomic mass that was disappearing. So it was suggested by the Swiss physicist Wolfgang Pauli that another particle must be formed along with the beta particle. This second particle would carry off the missing energy.

Such an additional particle

would have to be uncharged. The reason was that the beta particle (which was a negatively charged electron, remember) took care of all of the charge that had to be accounted for. The additional particle would also have to be very light, much lighter than even the electron, since almost all the mass was accounted for, too. The suggested particle might even have no mass at all. It might be nothing more than a "speeding nothing," consisting only of the energy that was contained in its motion.

The name suggested for this smallest of all small particles was the *neutrino*. This is an Italian word (it was first proposed by the great Italian physicist, Enrico Fermi) and means "little neutral one."

The neutron had been hard to detect. But the neutrino, with neither charge nor mass, was many times harder.

It is only when a particle collides with an atom and upsets its structure in some way that it can be detected by a scientist's watching instruments. But the elusive neutrino, according to calculations, could pass through trillions of miles of solid lead before disturbing a single atom.

Such a particle seemed hopelessly beyond reach. In fact, many scientists wondered if a "speeding nothing" could really exist. Perhaps it was just a figment of the scientific imagination. Perhaps Einstein's equation was wrong.

Found: the neutrino

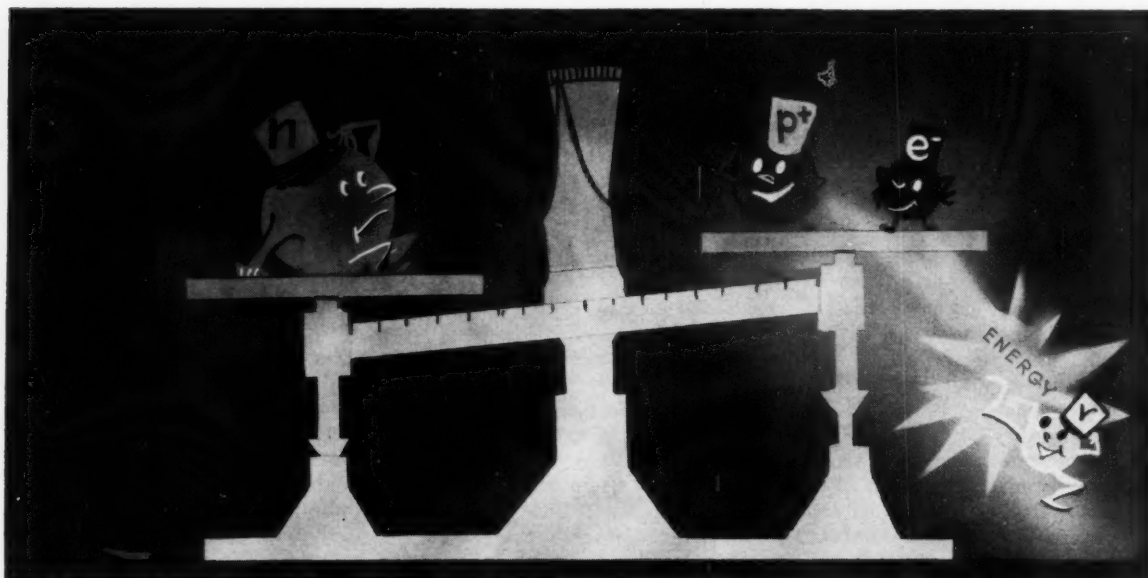
But in 1956, a quarter-century after the existence of the neutrino was first suggested, the chase ended. An ingenious set-up had been devised. It could detect the disturbance of even a single atom by a passing neutrino. In the case of such a disturbance, gamma rays of a certain energy would appear in certain intervals of time. Disturbance by any other kind of particle would not give the expected pattern.

The set-up was placed near a nuclear reactor, which was supposed to be producing quantities of neutrinos. Patiently, the investigators waited. They were well rewarded. Every once in a while, gamma rays were produced in just the expected pattern.

The tiny neutrino had been trapped. It really did exist.

[Conclusion, December 23 SIW: Scientists discover a bewildering array of sub-atomic particles.]

Illustrations for this article are from the new filmstrip, "What's in the Atom?" courtesy of Film Strip-of-the-Month Club, Inc., New York, N. Y.



PROTON AND ELECTRON formed from neutron don't have as much mass as neutron. Neutrino accounts for missing mass.

TRAITS AND TRACES

By Lynn Poole

■ How did primitive man build new civilizations? Did wandering tribes originate absolutely new civilizations when they migrated to uninhabited continents? Or did primitive man make contact with more highly developed people and borrow ideas, customs, systems?

Human geographers, who study man and his relationship to the physical world, do not agree on the answers to these questions. There are two schools of thought.

Two opinions

Independent Inventionists are convinced that primitive man invented each new civilization without help. They hold that even civilizations with striking similarities developed independently at different times, in different places.

Diffusionists are equally certain that advances by primitive men in one part of the world were made by borrowing from more civilized peoples in other parts of the world. Each new civilization then developed along the lines of its own regional differences.

There is an increasing volume of evidence in favor of the Diffusionists. Dr. George F. Carter has helped us to summarize for you the mass of facts leading most scholars to agree with the Diffusionists.

You undoubtedly know that the west coasts of North and South America were settled many, many thousands of years ago by primitive tribes who migrated from northeastern Asia over the Bering Strait

and fanned out across unpopulated lands on this side of the Pacific. Let's select these people as an example of the Diffusionists' scientific theory. More specifically, let's single out the early people of Mexico, Peru, and neighboring countries.

When the Spaniards arrived in that area, they found the Inca, Aztec, and other civilizations, all highly developed. The Incas told the white men that some of their Inca forefathers were also explorers. They had set out across the Pacific in a bobbing fleet of balsawood rafts with centerboards and returned in two years. Tales of amazing foreign lands were told by the explorers, who brought back with them carvings, food, and implements from the strange countries across the big ocean. The Spaniards believed the Inca stories of exploration, but, as the years passed, scholars doubted the tales and scoffed at them as mythical legends. "Cross the Pacific in such light craft?" scholars questioned. "Impossible!" But was it?

In 1947, the modern explorer Thor Heyerdahl and a crew sailed the balsawood raft, *Kon-Tiki*, across the Pacific for a distance of 4,300 nautical miles in 101 days. Heyerdahl calculated how a raft like his could make the return trip from Asia to the Americas. What's more, he confirmed the fact that South American coastal Indians, perhaps the Incas, sailed lightweight rafts 600 miles out to the

Galapagos Islands, where they fished and returned home with their catch. So the stories of the Incas were verified in the twentieth century. Incas could have sailed over the seas to the Orient and returned home with ideas and objects which they adapted to their own civilization.

They could have. But did they? The Diffusionists have uncovered fascinating evidence of similarities between life in the Americas, the Pacific islands, and Asia.

Coincidence or communication?

In early Peru, slit, hollow logs were used to produce music, for signal communications between tribes. The Peruvian log construction was identical with that of a log instrument played in Africa and in the islands of Polynesia. From pre-Spanish excavations in Peru, archaeologists have unearthed a conch-shell trumpet made of a Polynesian shell not native to Peru, though the trumpet was known by the same name in Peru and in Polynesia.

Indians of the Americas and Asians across the Pacific played on pipes of Pan, blowing the same notes and using the same musical scale. The pipes, identical in both areas of the world, were always played in pairs by two people. Studies of other musical instruments reveal that a thin flute found in both the Philippines and in South America was blown through the nose in both areas.

The odd similarities of blowing pipes of Pan in duet and of playing a flute by nostril could hardly be pure coincidence. Dr. Carter and his colleagues say, "It seems improbable that widely separated civilizations could have invented so many identical instruments." One civilization must have borrowed from the other, and, since the Asiatic is the earlier, the South American Indians must have borrowed from the Asiatics and the Polynesians.

Spurred by each new proof of early contact between East and West, Old World and New, scholars have searched more thoroughly into the subject. They have compared games played in the Americas with those from other parts of the world. Many are similar, some identical. Parchesi, which originated in India, was a national pastime in Mexico when the Spaniards arrived in that country. The rules and the playing board were exactly the same as India's.

Architecture, math and plants

Architectural studies indicate that there also must have been some trans-Pacific exchange of building designs. The trefoil arch of India framed doorways of buildings in southern Mexico. Other Oriental designs in constructions of the Americas included the sacred tree, tiger thrones, serpent columns, lotus blossoms.

Mathematics is basic to all civilizations, and we find that the circle zero was used in India, Peru, and Mexico. Records kept by making spaced knots on string or rope were common to China, Polynesia, and Peru. And the spacing of the knots for counting and record-keeping was identical.

Actually, growing things, not man-made objects, are the most convincing proofs of the Diffusionists' theory. Man may crossbreed and change plants and their fruits, but *he does not invent them*. Plants are natural creations with definite origins and natural homelands.

Scientists have determined that oranges originated in southeast Asia, wheat in the Near East, olives in the Mediterranean area. Pumpkins, squash, tomatoes, and potatoes came from the Americas; so

did the pineapple, which we may think of as a foreign fruit. The sweet potato and the hibiscus, both native to the Middle Americas, flourished long ago in Polynesia, where they were known by their American names.

Scientific tests by meteorologists and oceanographers have proved that seeds could not have been carried by air or ocean currents from the Americas to Polynesia, much less to Asia. So plants found in foreign lands must have been carried there by man. Conclusions reached by scientists about many plants are important to the study of migrations of primitive man.

The studies go into the sciences of biology and genetics and are extremely complex and technical. Dr. Carter has simplified for us the complicated story of the investigation into the origin of cotton by three scientists — Hutchinson, Silow, and Stevens.

Cottons of the world can be divided into three groups: (1) wild and domestic cottons of the Old World, (2) wild cottons of the New World, and (3) domestic cottons of the New World. When the scientists studied the cells of the New World domestic cotton under a powerful microscope, they discovered that it had twice as many hereditary units (chromosomes) as other cottons. To their surprise, they found two kinds of chromosomes, one of the Old World type, one of the New World type. They decided that early man must have transplanted an Old World cotton in the New World, where the two combined. This seemed a logical conclusion, but could the theory be proved?

The three research scientists searched the world to learn what two cottons, if crossbred, would give them the exact characteristics of the New World domestic cotton. After patient research, they discovered that by taking an Asiatic domestic cotton and crossbreeding it with a wild cotton of Peru they could create the New World domestic cotton. This proved that thousands of years ago human beings had transported cotton from Asia that crossbred with wild cotton growing on the shores of America.

With painstaking care, scientists have studied many plants and will investigate many more, continuing to follow the trail of early man as he moved around the world.

Other scientists compare notes and exchange theories as they study the development of civilizations. One contribution was made by Dr. G. Elliott Smith who, while on a vacation trip to Egypt, became interested in ancient methods of embalming the dead. Before a corpse was mummified, ancient Egyptians removed the brain, the heart, and vital internal organs and placed them in canopic jars (burial containers). Dr. Smith studied the skulls of Egyptian mummies and learned that the surgical incision made through the skull to remove the brain was a most unusual one. Every skull he examined had the same incision. Also, the abdominal incision on each mummy had been closed with a peculiar, awkward pattern of surgical stitching.

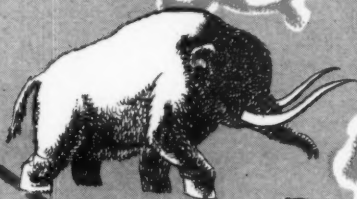
Like methods in embalming

A few years later, while visiting islands north of Australia, he examined embalmed remains of early man of that region. He found the same sort of skull incision and abdominal stitching that he had seen thousands of miles away in Egypt.

Since Dr. Smith was aware of the controversy between Independent Inventionists and Diffusionists, he next studied the skeletal remains of men who lived in the Inca civilization. You know, of course, what he found: the same unusual skull incision, the same stitching of the abdomen after the removal of vital organs. Egypt — Australia — America. Man borrowed from man. For the unique techniques to be handed from people to people, there had to be travel, migration, exploration.

Scientists find it fascinating to follow the trail of man around the world. There are exciting careers open to men or women in human geography and allied professions — anthropology, art history, geology, oceanography. You may want to take on the study of early man, of ancient civilizations, if you have a strong curiosity, a yearning for travel, a capacity for hard physical work.

Primitive tribes, chasing game, migrated from northeastern Asia across the Bering Strait to the Americas.



Voyage of Kon-Tiki proved ancient peoples could have crossed Pacific.



Architecture indicates link between Asia and Americas. Serpentine column resembles those found in Asia.

Scientists found New World domestic cotton was crossbreed of Old World domestic and Peruvian wild cotton.



Polynesian conch-shell trumpet was found in Peru.

Some method of keeping records with knots on string was used in China, Polynesia, and Peru.



Granger
entists
d will
nuing
an as

notes
study
ations.
by Dr.
on a
ne in-
of em-
corpse
ptions
t, and
placed
l con-
l the
s and
cision
remove
d one.
d the
minal
been
ward

siting
e ex-
early
d the
d ab-
seen
Egypt.
of the
ndent
ts, he
ins of
viliza-
at he
ll in-
f the
vital
a —
man.
to be
people,
ation,

g to
d the
reers
uman
ns —
ology,
nt to
n, of
ave a
g for
ysical

By Auguste Piccard

IN THE

Piccard and Kipfer were making

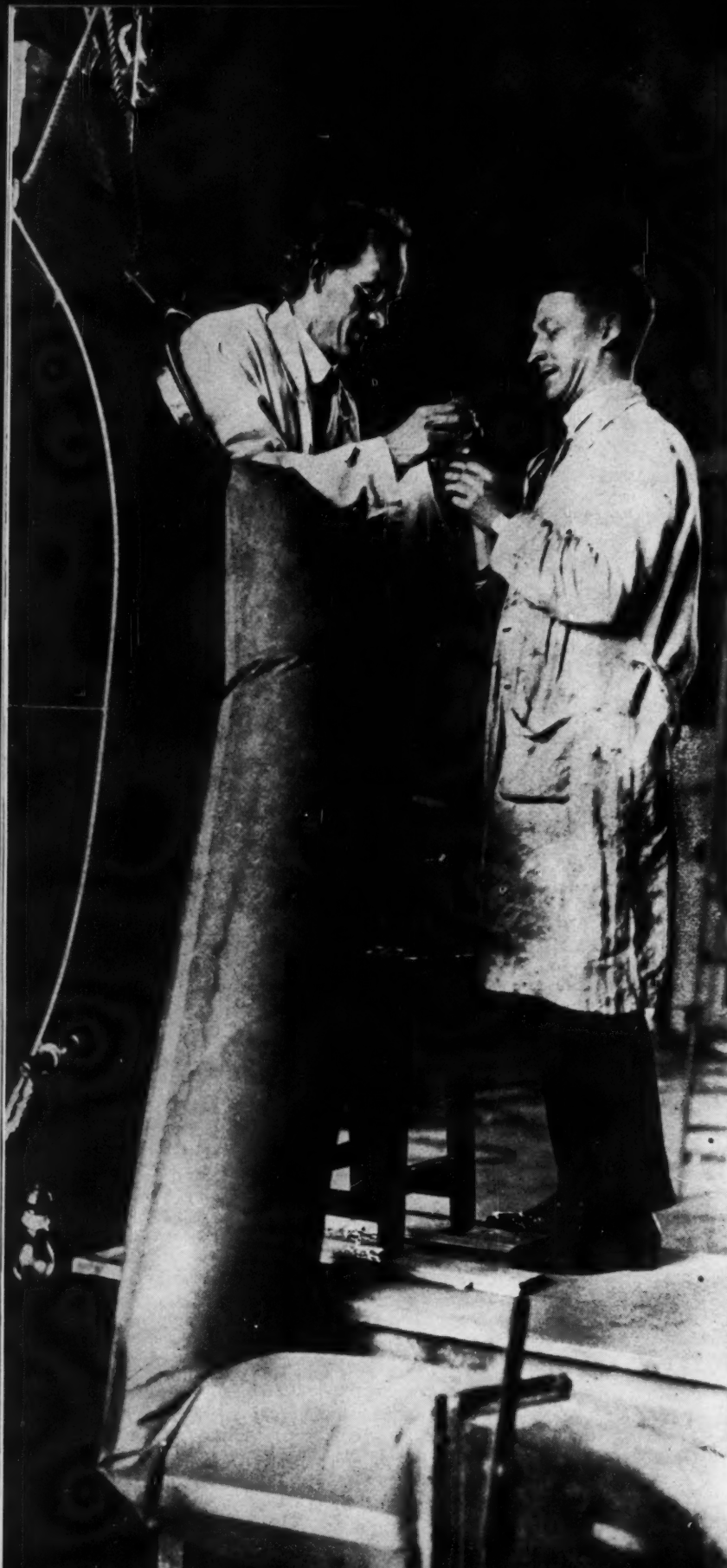
CONCLUSION ■ At last here we are in the stratosphere!

Around us the sky. The beauty of this sky is the most poignant thing we have seen: it is sombre, dark blue or violet, almost black. If the air were perfectly transparent, we should see the earth over a radius of 280 miles, and our visual field would cover 246,000 square miles of the planet (more than the surface of all France). But beneath the stratosphere there is the troposphere, whose upper limit on that day was about $7\frac{1}{2}$ miles; it is much less transparent. At the horizon we perceive the confines of the two zones, as if drawn with a ruler. If one looks obliquely across the troposphere, the earth, so distant, is invisible: there is nothing to be seen but fog. But the more the glance is directed downwards, the more visible is the earth. Beneath us is the Bavarian plain. But even if we look vertically down, the picture is blurred as in a bad photograph. There is, in fact, between us and the earth nine-tenths of the atmosphere, almost as much as if, at sea level, we were looking at the moon. Alone, the mountains emerge from the foggiest regions of the troposphere. At first hidden by clouds, they reveal themselves bit by bit: a summit, then another; at last, all the snowy chains of the Bavarian Alps and the Tyrol, which we are approaching gradually.

In spite of the splendour of the spectacle, we took precautions. We threw out over a hundred pounds of ballast, which caused us to rise some hundreds of yards.

FROM HIS spherical gondola, Professor Piccard confers with assistant Kipfer.

Copyright © 1956 by Auguste Piccard. *Abenteuer im Weltall*



HSTRATOSPHERE

making up into the stratosphere. But they could not open the valve for descent. How were they to get down?

we are

beauty
moignant
sombre,
t black.
y trans-
e earth
and our
246,000
(more
ce). But
there is
er limit
2 miles;
At the
fines of
with a
y across
so dis-
nothing
ne more
wards,
th. Be-
in. But,
own, the
ad pho-
between
s of the
ch as if,
g at the
ountains
gions of
dden by
lves bit
ther; at
of the
l, which
lly.
r of the
ons. We
pounds
s to rise

We soon made a very unpleasant discovery: the rope which controlled the valve was not working. It was tangled with the supplementary rope which was affixed at the moment of departure. Now, if we could not open the valve, we could not let the gas escape, to begin the descent. Instead of obeying us, the balloon would go down only when external conditions permitted it, that is to say, when it grew colder at sunset. Where should we be then? Over the land? Or above the Adriatic?

As it descended, the balloon would grow longer; the rope operating the stopped-up valve would therefore be stretched out and would open the valve, accelerating our descent more than we wished.

However, to carry out our programme and reach that altitude where the pressure is only one-tenth of an atmosphere, we threw out more ballast and soon we saw a difference on our barometer between the two meniscuses of 2.992 in. exactly. Being used to seeing in the laboratory, on our barometers, columns of mercury of 29.92 in., we had a curious sensation when we read a barometric height reduced to one-tenth of what we call its normal value.

We should have been perfectly happy if it had not been for this incident of the valve. The future was uncertain. What were we to do? We decided not to throw out any more ballast, partly to shorten our trip, and partly, also, to be able to dispose of what remained at the moment of landing. Then we decided to pack up the instruments. If the balloon, as it drew out in length, itself pulled open the valve

and thus occasioned too sudden a landing, we had to take precautions against being injured by loose objects.

We tried once more to open the valve by turning the windlass winch around which the cable was wound, by means of a crank placed inside the cabin. But the cable broke clean off, which definitely put at an end any hope of controlling the balloon.

There we were, prisoners of the stratosphere. Fortunately we had at our disposal a good reserve of oxygen and of alkali, which is used to absorb the carbon dioxide produced by our breathing. Although our programme provided for a landing about midday, I had a reserve which should have let us remain shut up in our cabin until sunset. Provided, at least, that we could keep the cabin airtight. Having felt several times, in our ears, a sudden lowering of pressure, we perceived that we were once more losing air through the hole near the insulator; the vaseline had run out through the tow. So the struggle for life began again. The longer the trip took, the greater was the danger of reaching the Adriatic. We had a drift indicator which hung 50 yards below the car. As long as land was visible, it permitted us to determine our speed and the direction of our drift. The direction was, in fact, towards the Adriatic. Our speed was, luckily, very low; if it did not increase, we were sure not to leave *terra firma* during the day. In the stratosphere the wind is often very violent. On certain days it would have borne us as far as above the Persian Gulf. If I had known the

mountains which surrounded us, I could have found our position. But the view was too often obstructed by clouds to permit us to follow our course on a map.

As a last stroke of ill-luck, one of the large mercury barometers broke as the result of an awkward movement. The liquid metal flowed to the bottom of the cabin. Now, in certain cases, aluminum can be rapidly eaten away by mercury. Fortunately a good layer of paint protected the cabin. Nevertheless the presence of mercury was not reassuring. If only we had possessed a little pump with which we could have sucked it up! We had with us a rubber tube. If only, we thought, we had had a vacuum cleaner! As a matter of fact, never had a physicist at his disposal more vacuum than we had! The whole stratosphere was at our disposal. We connected our tube with a tap which led outside and we placed the other end on the cabin floor. The mercury was sucked up and thrown outside as well as the condensed water which had accumulated at the bottom of the sphere. But we hadn't come to the end of our difficulties.

We had departed before sunrise, and we had traversed at high speed those zones where the temperature was between 50° and 75° C. below zero. The walls of the cabin were then very cold and its interior was rapidly covered by a good layer of frost. It was as if we were in a drop of crystal. If the situation had lasted, we should have suffered seriously from the cold. But soon the sun rose, the stratospheric sun. Its radiance is twice as intense as at sea level. The aluminum became

Professor
t Kipfer.

card. Abri Sky and Sea by Auguste Piccard with the permission of the publisher, Oxford University Press.

heated and the frost dropped off. It began to snow in our cabin.

Bit by bit the temperature rose. 70° F. was very pleasant. 85° was bearable. But over 100° was too much! We sat down as low as possible in the sphere, as there it was coolest, but still we got very thirsty. I had asked that two big bottles of water should be put in our cabin; we found only one small one. Beneath the flooring with which the rounded bottom of our cabin was covered, the condensed water had collected; there would have been enough of it, but dust, oil and mercury made it into an undrinkable emulsion. Luckily Kipfer discovered a spring: fresh water, clean and distilled, flowed along the wall, on the shady side; there was not much of it, but it sufficed to wet our tongues from time to time. I found something even better: when we poured liquid oxygen into an aluminum goblet and waited for the oxygen to evaporate a thick layer of frost was formed outside. But it was so cold it burnt to the touch, for it was formed at -350° F.; we had to wait a bit until its temperature was that of melting ice.

12:30 P.M., the sun at its zenith. At last the entire cabin came into the shadow of the balloon; and the temperature sank. One side of the cabin was painted black, the other being left bright. I had intended, by making the balloon turn round, to regulate the temperature, since black absorbs more heat than a bright metal, but the motor intended to bring about this rotation had been damaged at the time of departure; the whole morning it was the black side which had been exposed to the sun. During the afternoon the balloon turned round, and so we no longer had to suffer from the heat.

Towards two o'clock in the afternoon we began to descend very slightly. But a rapid calculation showed us that at this rate we should take fifteen days to get down! As a precaution, we decreased the outlet from our oxygen apparatus and we kept as still as possible so as not to turn too great a quantity of this precious gas into carbon dioxide.

3 P.M. The speed of descent is more marked. However, it would

still take twenty-four hours at this rate to land. All the same, the descent is getting faster; that is the essential thing.

4 P.M. 5 P.M. 6 P.M.! The hours are passing. We are crossing the Bavarian Alps. The sun is going down. The balloon, now colder, descends faster and faster.

Going down

8 P.M. Altitude 7½ miles. At last we had left the stratosphere. By the fog which suddenly covered the distant horizon we saw that we were passing into the troposphere. Below us twilight flowed through the valley of the River Inn. On the ground, we found out later, people saw an unusual sight. The balloon, still in the sun's rays, appeared to the earth-people brilliantly illuminated against the dark sky. Until today, only the planets and the moon have been seen lighted up in this fashion. So they took us for another heavenly body. To the observers nearest at hand, the illuminated part of the balloon appeared in the form of a crescent. Had a little moon been born? Nothing was missing; it even had a halo. This was produced by the light reflected by the balloon and diffused in the fogs of the already obscured troposphere. (On the 18th August, 1932, the reverse took place: our friends who were following us in a car were speeding in the direction of Venus, which they took for our balloon.)

The sun disappeared beneath the horizon. We descended more and more rapidly. Now it is known that if more ballast is thrown overboard than is necessary to stabilize a descending balloon and the valve is not opened, the balloon will generally climb again to its earlier position of equilibrium. We had to be very careful then, when throwing out ballast, not to go back at one jump to 10 miles up. It was just unfortunate if the landing proved a little rough.

By means of the tap which communicated with the open air, we slowly decreased the pressure in the cabin so that we could open our manholes as soon as possible.

Kipfer watched the barometers. At 15,000 ft. he announced equal pressures within and without. We

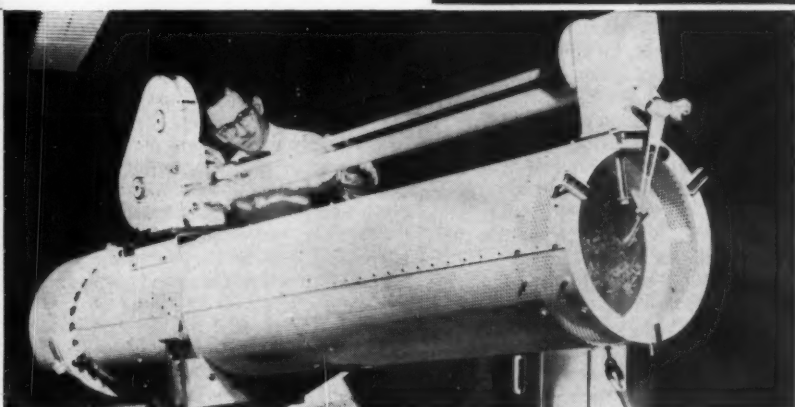
opened the manholes immediately and put out our heads. After having been shut up seventeen hours, we were at last in the open air. Above us, the starry sky. Beneath, the high mountains, snow and rocks. The moonlight was magnificent. Two little clouds were lighted up from second to second by stormy discharges; but we saw no lightning nor heard any thunder. To be ready for anything, we prepared our parachutes, but the balloon very luckily left the stormy zone.

A glance towards the horizon; it still formed a straight line. But soon gloomy silhouettes emerged: mountains. We were already lower than the highest peaks. Things were going to happen fast. We were in the high mountains near a pass covered with ice. On the south side it appeared to lead rapidly down towards the plain, but we were drifting northwards. Because of the danger of climbing again to 10 miles with the manholes open, we dared not cast out any ballast, and were obliged to manoeuvre only by means of the ripping panel. We touched a very steep field of snow. In my hand I held the strap which allowed me to open the panel and to empty the balloon almost instantly. But I took good care not to do it; the site was not suitable for a landing. The balloon bounced and flew over a glacier. It was a maze of crevasses. One moment I could see the lights of a village, and I flashed a signal towards it with a torch. (The next day we learnt that this signal was seen perfectly from Gurgl.) But the village disappeared in the valley. At last we approached a flat place free of crevasses. Now was the moment! Kipfer pulled the strap of the ripping panel; the balloon quickly emptied; we touched the ice, the cabin rolled a little, then came to rest.

My manhole was on top, so I had an unrestricted view. The envelope was floating above us. The wind was so light that at every moment it threatened to fall on the cabin; then it leant over and lay down on the glacier; the opened ripping panel being underneath, it emptied only very slowly. A glance into the dark cabin showed me a heap of strange objects: 400 lbs. of instru-



MODERN BALLOONING: rocket rises for high-altitude launching (left); Air Force biologist David G. Simons sets altitude record of 19 miles (above); scientists use balloons to lift telescope and camera above earth's atmosphere (right and below) to study sun.



ments, 750 bags of small shot, all scattered about upside down. And underneath, Kipler, who was slowly picking his way out towards the top.

We had landed at an altitude of some 8700 ft. Switzerland? Austria? Italy? We bivouacked where we were. The place would have been fairyland if it had not been so cold! Wrapped up in the balloon material, I went to sleep, but I started from sleep from time to time, woken by the noise of a waterfall which in my dream I mistook for the whistling of our air leak! At dawn, from aeronauts we became Alpinists: linked by a double rope, sounding the snow at every step with a bamboo stick

found in the rigging of the balloon, we reached the edge of the glacier, and, seeking out passages across the rocks, we went down slowly towards the valley. At midday a patrol of skiers came from Gurgl to our rescue, reached us, and led us to the village. It is with gratitude that I think of the valuable help given to us as much by the mountaineers as by the authorities in the Tyrol. Forty men, twenty soldiers and twenty peasants, carried the envelope of the *FNRS* on their shoulders from the Gurgl glacier to the village, without a path or on the worst trails, and all this without one tear in the delicate material.

A few days later, at Zurich,

where the Swiss Aero-Club welcomed us in triumph, its president, Colonel Messner, congratulated us, and expressed the hope that the world altitude record which we had just set up would not be beaten for many years. In my reply I had to contradict him.

"It will be a fine day for me," I said, "when other stratospheric balloons follow me and reach altitudes greater than mine. My aim is not to beat and above all not to maintain records, but to open a new domain to scientific research and to aerial navigation."

(Note: If you enjoyed this, look up the account of Piccard's descents in his bathyscape.)

Science in the news

First goal: the moon; then Mars and Venus

The Army's first moon shot, scheduled for early this month, will be different from any of the Air Force's three tries. Army rocket men won't try to put their lunar probe into an orbit around the moon. Instead they'll aim it directly at the moon, though they don't expect a hit. If it goes that far, the 30-pound vehicle will probably shoot past the moon and slip into an orbit around the sun.

The Army's lunar rocket will consist of a Jupiter IRBM, a cluster of smaller rockets, and the probe itself. The job of the smaller rockets is to boost the probe's speed to the point where it will escape the earth's gravitational field. If all goes well, the probe should reach the moon's vicinity in 33 hours and 45 minutes — a full day less than the time allowed for the Air Force's 82-pound Pioneer. The Army vehicle is being speeded up so that it will meet the moon when that body appears over an Army tracking station in California. Then the station can tell by the vehicle's signals whether it has hit the moon or missed.

With the moon the immediate goal, scientists are nevertheless drafting plans for flights to Mars and Venus. The Air Force's Thor-Able rocket, now used for moon shots, could send an instrumented payload to both planets. But the time isn't yet right. The best time for a shot at Venus will be in 1959. The planet will then pass within 25,702,000 miles of the earth — its closest point. Mars will come closest in 1960-61, when it will be about 35 million miles away.

A speed of 25,000 mph will be needed to send payloads to Mars and Venus. The trip to Venus, using today's rockets, would take about 151 days; to Mars, about 247 days. But space craft with nuclear engines could reduce this time. Nuclear engines, now in early test stages, will maintain higher speeds than present chemical engines.

Scientists are also hard at work on the problem of sending men into space. Last month, space experts met in Texas to discuss solutions to problems such as these:

- How to keep men alive in space without huge stores of oxygen and food. The most likely solution: using the waste products of space men to raise

plants that will provide them with food and oxygen. It will apparently take some time to work out this problem.

- How to counteract boredom on long space flights. Experiments show that boredom could lead to irritability, decrease reasoning power, and, sometimes, hallucinations.

- How to condition men to get along on a minimum of oxygen. Tests in the Rocky Mountains have shown that, given time, man can increase his stamina and his working efficiency in highly rarefied air.

Age of the universe probed by astronomers

Most astronomers agree that the universe was born in a terrible explosion. They believe that fragments shot out from the blast gradually became galaxies of billions of stars. These galaxies have been speeding away from each other ever since. How long ago did the explosion occur? Seven to 13 billion years, according to an estimate based on recent studies with the 200-inch telescope at Mount Palomar.

Palomar astronomers are trying to determine whether the universe is now expanding at a slower rate than before. There are indications that the galaxies are slowing down. If this is so, the forces of gravity could eventually overcome the momentum of the expanding universe. The galaxies would then move back toward each other. When they finally collided, another explosion would probably take place. Then the universe would begin expanding all over again. One astronomer suggests the possibility of a pulsating universe. This universe would alternately expand and contract, each pulse lasting many billion years.

Scientists to study why clean dishes aren't clean

Atomic research techniques are being used to investigate a health hazard that may lurk on "clean" dishes. It is a greasy film that clings to dishes, glassware, and utensils even after repeated washings. Harmless in itself, the film traps bacteria, keeping them from being washed away. The University of Michigan, supported by a grant from the U. S. Public Health Service, will launch a three-year study of the problem.

The film, which makes dishes feel slippery, is often blamed on soap or chemicals in the water. But the Michigan research team says it's caused by neither. They think it comes from various animal and vegetable fats in food.

The researchers will smear mountains of dishes with radioactive tallow, cooking oils, and animal fats, then wash them. At each stage of washing, they will measure the radiation present. This will indicate how much greasy film remains on the dishes. After that, the team will contaminate hundreds of dishes and glasses with radioactive bacteria. They will determine by a radiation count how many germs are present on seemingly clean dishes after routine washings. From what is learned, the researchers hope to find a way to remove the film.

If they do, we're all in for an unexpected bonus: with the film gone, dishes will shed water and dry rapidly and evenly, all by themselves.

Chemist says life exists on millions of planets

While man prepares to leave Earth and explore space, living creatures on other planets may be making similar plans. The known universe may contain some 100 million planets with well-organized life on them, says Dr. Melvin Calvin, a University of California chemist.

Life on these millions of planets might — or might not — be similar to that on the earth, says Dr. Calvin. Like the earth, these planets are about five billion years old. Their atmosphere is thought to be similar to ours, as is their carbon content and their distance away from an energy-producing star. Living creatures on the planets could probably see and hear and, in some cases, might be capable of thought. In fact, adds Dr. Calvin, on some planets there might be life even more advanced than man.

Dr. Calvin's findings are based in part on laboratory experiments on the development of living cells. He and other scientists see no reason why the same pattern wouldn't have been followed on other planets. As for higher, more complex forms of life such as plants and animals, their development is harder to trace. But the scientists feel that plants and animals on other planets would have some characteristics in common with those on the earth.



Home on the moon? Scale model of moon building has protective shield above roof to ward off rains of interplanetary meteoric dust. Sliding doors on plastic bubble observatory (foreground) would protect it from intense ultraviolet radiation. Building would contain living quarters, research labs, maintenance shops for spaceships, control tower. Model was designed by Wonder Building Corporation of America.

Potassium protects plants from strontium-90

Potassium, a chemical used in fertilizers, can help man combat the dangers of strontium-90, which is radioactive. This is the most dangerous by-product of fall-out from nuclear blasts. Strontium-90 gets into the soil and is absorbed by plants. These are eaten by animals that provide food for man. Once in the human body, strontium-90 settles in the bones and is almost impossible to remove.

Experiments made by Dr. Willard F. Libby of the Atomic Energy Commission show that potassium greatly reduces the strontium-90 absorbed by plants. Dr. Libby grew radishes in earthen pots. To these he added varying amounts of strontium-90 and different kinds of chemical compounds. When the plants matured, they were burned. Their ashes were analyzed to determine the amount of radioactivity each plant had absorbed. Of all the chemicals tested, potassium proved most effective in protecting the plants from strontium-90 fall-out.

Three-eyed monster is relic of ancient past

It has a backbone like a dinosaur, ribs like a tortoise, a skull like a bird, an overhanging beak, and a third eye in the middle of its forehead. What is it? It's a tuatara. Scientists are studying the tuatara to learn more about prehistoric

animals. For it appears to be the lone surviving link to the Age of Reptiles.

Tuatara live in colonies on several islands north of Auckland, New Zealand. Though they're not lizards, tuatara have spines on their backs and are similar to lizards in other ways. They belong to an order of reptiles called Rhynchocephalia. These reptiles flourished during the Triassic period, some 150 to 190 million years ago. Scientists think the reptiles came to the New Zealand islands by means of an ancient connection with a land mass to the north of Australia.

One of the many fascinating things about a tuatara is its third eye. This is completely formed, but is buried beneath folds of skin. It can barely distinguish the difference between light and darkness. Ancient ancestors of the tuatara used the third eye to watch for danger from above, while the other two eyes were busy searching the ground for food.

Attention rocketeers: write to the U.S. Army

The U.S. Army wants to encourage amateur rocketeers — and at the same time keep them from blowing themselves up. So it has prepared a special booklet on rockets, available on request from: Captain Bertram R. Brinley, Information Section, Headquarters, First U.S. Army, Governors Island, New York 4, N. Y. An Army survey has so far turned up more than 1,500 clubs and individuals experimenting with rockets.

News in brief

● Observing the moon, a Soviet scientist noticed a brilliant light coming from a lunar crater. A study of the light's spectrum revealed streaks of carbon. His conclusion: a volcano had erupted. This caused quite a stir, for scientists had previously found no reliable evidence of volcanic activity on the moon. But British scientists disagreed with the Russian's conclusion. What he saw, they suggested, was carbon dioxide gas escaping from a lunar crater. Cosmic or solar radiation probably illuminated the gas as it reached the moon's surface.

● "Space suits" will be the everyday work clothes of technicians at the Navy's new Bureau of Aeronautics plant at Bridgeville, Pennsylvania. The suits will protect men who work in a sealed room filled with pure argon gas. In the room, the men will process metals for missiles, rockets, and space vehicles. These metals must be processed in an airless atmosphere. Reason: the high temperatures needed to "hot-work" them for space travel conditions would cause them to oxidize rapidly in ordinary air.

● Man adapts more readily to heat than he does to cold, reports a physiologist. Man's scant hair offers little insulation against the cold. But he has excellent equipment to help him shed heat. His blood vessels enlarge, enabling more blood to carry more heat from deep in the body to the skin surface. There, heat is removed from the body by sweating.

● A "living insecticide" is outdoing its chemical alternative, DDT. In California, it is wiping out the cabbage looper and the cabbage worm, destroyers of cauliflower, cotton, cabbage, and lettuce crops. The "insecticide" — billions of spores of the bacterium, *Bacillus thuringiensis* — is dusted on crops that are eaten by the worms. The spores act as a poison. They are not harmful, though, to human beings or other warm-blooded animals.

● Six to eight atomic reactors will be built in Europe to supply much-needed power. They will be built under the terms of an agreement between the European Atomic Energy Community and the United States. This country will lend \$135 million for the project and supply enough enriched uranium to last 20 years. Euratom countries will share what they learn with the U.S. The reactors are expected to produce 1,000,000 kilowatts of power a year, enough for a community the size of Chicago.



springboards to projects

How big is a molecule?

Have you ever wondered how a scientist determines the size of a molecule? For even the electron microscope is scarcely able to make out the dimensions of the largest molecules. Yet, with simple apparatus, the application of some arithmetic, and the formula of the volume of a cylinder, you can get a rough indication of the size of some molecules. You can do this by using an ingenious method developed by Irving Langmuir in 1916. Here is how it works:

If two liquids that do not mix are put together, they will separate into layers. The lighter one will float on the heavier. You see this happen when a drop of gasoline is placed in a puddle of water. The gasoline immediately spreads across the surface of the water, giving rise to the typical rainbow colors. One drop of gasoline might spread out into a circular area several feet in diameter.

How thick is the film of gasoline? This can be told from the colors. Each color represents a different thickness of the film, from two to many molecules thick. But suppose you could spread the gasoline over the surface so that it was only one molecule thick (you'd know this by the absence of the color fringes). You could then compute the size of a single molecule. For, if you knew the exact volume of the gasoline originally used, this should equal the volume of the highly flattened cylinder made by the thin film of gasoline. This volume is the area of the circle of gasoline multiplied by the thickness of the film. Since the film is a mono-molecular layer, this "thickness" is roughly the size of the molecule.

Actually, gasoline is not suitable for this experiment, because it does not readily form a mono-molecular layer. But a substance such as oleic acid is suitable. Oleic acid ($C_{17}H_{33}COOH$) is an elongated molecule. The acid end, containing the $COOH$, has a very strong attraction for water molecules, while the hydrocarbon end does not. As a result, if a small drop of this oily

acid is placed on a water surface, the $COOH$ ends will push their way down into the water. This will cause the liquid to spread out into a mono-molecular layer (Fig. 1). Of course, nothing must impede the spread.

For your purposes, the area of the surface covered by the film must be made visible. A thin layer of oil placed on the surface of the water will be pushed aside as the acid end of the oleic molecule digs into the water. This will form a ring around the oleic acid film and definitely outline the area.

Here's how to go about the measurement. Get a small quantity of oleic acid (U.S.P.) from your local chemical supply house. Five cubic centimeters will be more than ample. Since one drop would make a mono-molecular layer several feet in diameter, you must dilute it. Yet you must know precisely how much oleic acid you are using. So, using a graduated cylinder, measure 5 cc. of oleic acid and 95 cc. of alcohol. Mix them thoroughly in a bottle. A single cc. of this mixture (5 per cent solution) will contain $1/20$ cc. of oleic acid. Now measure off 5 cc. of the mixture. Once again, dilute it, this time with 45 cc. of alcohol. The dilution is now $1/2$ of 1 per cent. Each cc. contains $1/200$ cc. of oleic acid. This is the dilution you'll use.

Now get a plastic tray. Extreme cleanliness is most important in this experiment. It is particularly important in the case of the tray. Clean it with a synthetic detergent, and rinse it well. Then fill it to a depth of 1 cm. with clear water. With a medicine dropper, place a drop of oil on the surface of the water. (Crankcase oil from a car is excellent.) The oil will cover the surface of the water. Using a clean medicine dropper, carefully place a drop of the oleic acid solution at the very center of the tray. The oleic acid will push the oil outward, forming a well-defined circular area (Fig. 2). Measure the diameter of the area.

Using the dropper, determine the

number of drops required to make a cubic centimeter. Knowing that each cc. of the oleic acid solution contains $1/200$ of a cc. of oleic acid, you can compute the volume of acid in one drop. Suppose you find that 20 drops make 1 cc. Then each drop of solution contains $1/4000$ cc. of oleic acid. Let's say the diameter of the film is 40 cm. Then, volume = area of film \times thickness of molecule, or:

$$\text{volume} = \pi r^2 \times h$$

$$1/4000 \text{ cc.} = 3.14 \times (20)^2 \times h$$

In this case, the size of the molecule turns out to be about .0000002 cm., or 2×10^{-7} cm. Of course, many assumptions and "rounding offs" were made in the experiment, so the accuracy may be questioned. But the method certainly gives a good approximation of the order of size of a molecule.

This method may be used to measure the molecules of such materials as stearic acid and other fatty oils. It suggests many avenues of experimentation to the student interested in laboratory and project work.

Illustrating Newton's first law

"A body in motion tends to remain in uniform motion in a straight line unless acted upon by some outside force," according to part of Newton's first law of motion. If, then, no forces act upon a body, it should remain in its relative state of motion (or rest) forever.

When it comes to illustrating this point, however, you find that this state is achieved not by eliminating the forces acting on a body but rather by balancing them out. For example, to keep an airplane in level flight at a constant velocity, you make the lift force exactly balance the weight of the plane, while the drag is counterbalanced by the thrust of the propeller. Thus, you must always balance out the forces of gravity and friction. While there is no place on earth (or, for that matter, in the universe) to which you could take a body to get away from the effects of gravitation, you can reduce its friction to practically zero. Thus you can get a better

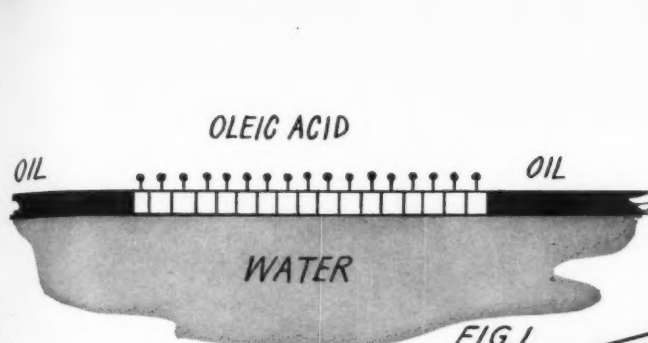


FIG. 1

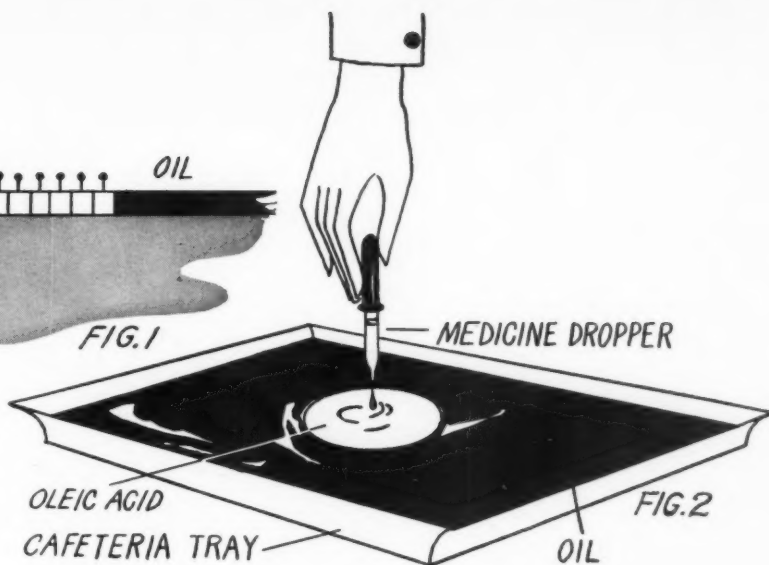


FIG. 2

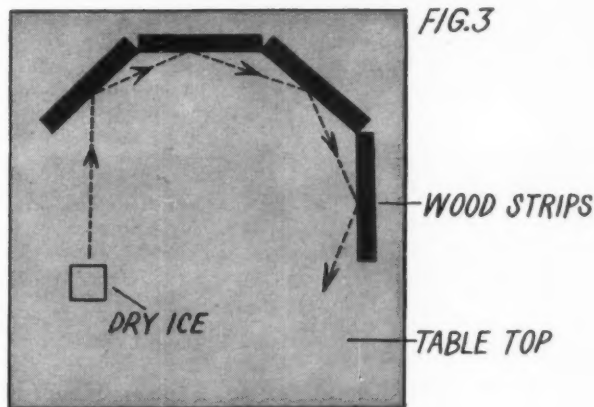


FIG. 3

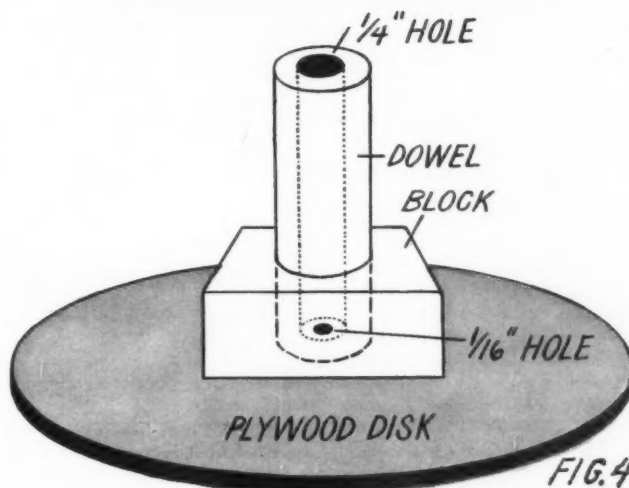


FIG. 4

Drawings by LoCurcio

idea of how forces change the relative state of motion of a body.

Obtain a block of solid carbon dioxide (dry ice). Use a piece that has a flat side of about 4 x 4 inches. Set the block at the end of a smooth-topped table (do not handle dry ice with your bare hands). Supply a force momentarily by striking the dry ice sharply with a ruler. The block of dry ice, riding on an almost frictionless layer of gas, will move along the table top with a constant velocity and in a perfectly straight line. To show that it requires a force to change either its speed or direction, allow the block to strike and then rebound from a strip of wood placed diagonally to its direction of motion. Use a series of such strips, arranged as in Fig. 3, to show that uniform motion in a circle requires the application of a constant force and is therefore properly referred to as accelerated motion.

If no dry ice is available, you can make a relatively frictionless "puck," as shown in Fig. 4. A length of dowel is inserted into a block of wood. The wood, in turn, is cemented to a disk of plywood or Masonite. A 1/4-inch-diameter hole is drilled through the dowel and block. An opening is made through the Masonite into the drilled hole by means of a thin drill (1/32-inch to 1/16-inch in diameter). Then the mouth of an inflated balloon is slipped over the dowel, and the puck is placed on a smooth table. The air from the balloon, coming out of the tiny hole at the bottom of the puck, will support the puck. In fact, the puck now rides on a thin film of air. The puck will behave in very much the same way as did the dry ice. Once set in motion across a smooth table, it will continue to move with uniform velocity and in a straight line unless acted upon by some other force.

If a tiny hole is drilled into the side of the wooden block, a reaction (or jet force) will operate. The puck will then accelerate. With a little ingenuity, you can design pucks that will slow up, rotate, or accelerate.

— THEODORE BENJAMIN

Marilouise Melcer of Los Angeles, California, writes:

What is magnetohydrodynamics?

This tongue twister describes a new field in physics that is just as complicated as its name. Magnetohydrodynamics is the study of the motion of charged particles when magnetic forces are acting on them. It is used in theoretical studies of galaxies and in controlled hydrogen fusion reactions.



Tommy Cole of Elkton, Maryland, writes:

Does a toad in South America eject a fluid that can cause warts?

No. The belief that any toads are capable of causing warts comes from folklore, not fact. Many toads have their own so-called warts. But these are really small glands. They secrete a bitter liquid that helps the toad ward off its enemies. When a person picks up a toad and handles it roughly, the animal won't hesitate to release the substance. Though not dangerous, the secretion can be painful when it gets into the eyes or into a cut in the skin. Toads that secrete liquids are found in all parts of the world.

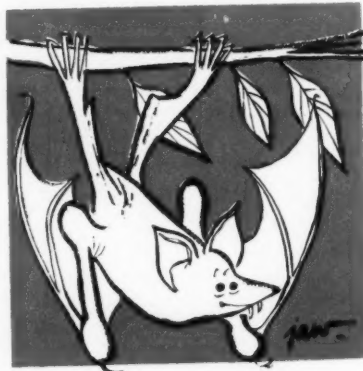
Harold Knowles Jr., of Murfreesboro, Tennessee, writes:

Why do bats sleep hanging upside down?

That's a hard question to answer. First, not all bats do hang upside down. Some crawl into crevices or other out-of-the-way places during their non-flying, resting hours. And those that hang upside down do more than sleep in that position. Congregating in large



groups, they often have noisy "social hours." The upside-down position has at least one advantage: the bats can easily take wing to pursue flying insects. Essentially creatures of the air, bats are unable to walk. Their knees bend backward, in the opposite direction from ours, which suits their hanging posture. Bats that hibernate stay this way all winter. Usually they hang by the claws on their feet, folding their long, umbrella-like wings. Sometimes they hang by one hind foot and a thumblike hook on one of their wings.



Louis Borgenicht of Larchmont, New York, writes:

Is it true that luminous watch dials emit harmful radiation? If so, to what extent?

Yes, according to a recent study at the Philadelphia College of Pharmacy and Science. The study showed that luminous-dial wrist watches vary a great deal in their radioactivity. But

the most active ones tested, if worn twenty-four hours a day for five years, could deliver 5 rem of radiation. Five rem is considered the maximum amount of radiation a person should receive by the time he is 30. Radiation from the watch dials tested was several times greater than radiation from natural sources. It was more than 100 times greater than that now received through radioactive fall-out. The study concluded that the advantage of a luminous-dial wrist watch is not worth the potential radiation hazard.



Arlene Paiva of New Bedford, Massachusetts, writes:

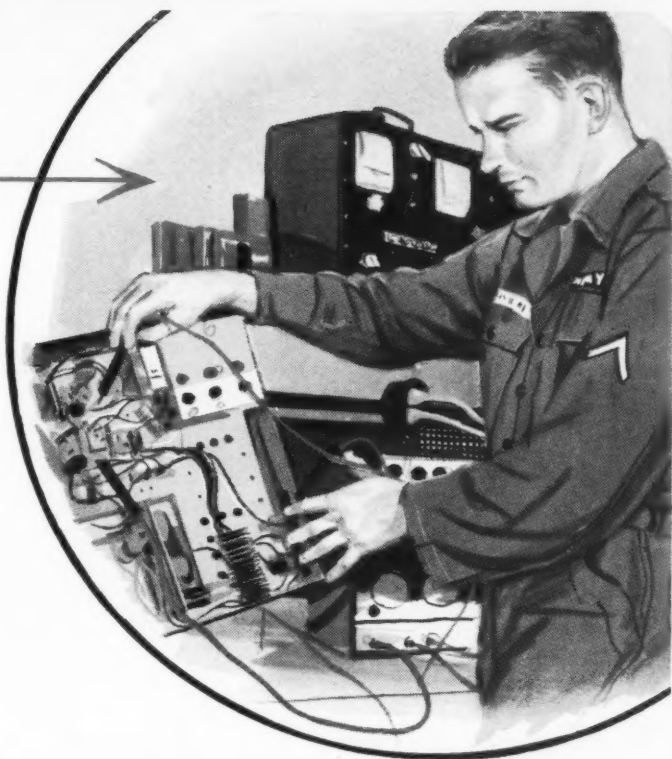
What is the difference between a comet and a meteor?

There are many conflicting opinions about comets and meteors. But a number of astronomers adhere to the following: A comet is composed of frozen gases in which tiny metallic or stony particles may be buried. Comets have large dimensions and small mass. Some revolve around the sun in elongated orbits; others appear to enter and leave our solar system. Despite their speed, comets are so far from earth that their movement is not apparent. A meteor, on the other hand, appears as a brief, bright streak of light in the sky. A meteor begins as a small mass of stone or metal in space. When it enters the earth's atmosphere, friction causes the meteor to glow. Most meteors burn up in the atmosphere.

Questions from readers will be answered here, as space permits. Send to: Question Box, Science World, 575 Madison Avenue, New York 22, N. Y.

JOIN THE ARMY'S SELECT CIRCLE OF KEY PERSONNEL

*be an
Army
Graduate
Specialist!*



CHOOSE YOUR TECHNICAL SCHOOLING BEFORE ENLISTMENT

For high school graduates only . . . a unique Army program! Now, by enrolling in the Army Graduate Specialist Program, you can *choose* the exact technical schooling you want—and have your choice guaranteed *before* you enlist! Graduate Specialists study and work with the select circle of Army specialists who are pioneering many of the exciting technological advances of our times. That's why Army Graduate Specialist schools can offer you the very finest technical training and equipment. That's why you can get technical schooling worth thousands of dollars—at no cost to you!

Graduate Specialists choose from 107 courses! As an Army Graduate Specialist, you'll be able to choose from 107 valuable technical courses in such fields as guided missiles, medicine, finance, photography, communications, electronics...and many more. Here's your chance to get a fine headstart in the field that interests you most!

High school seniors have "Early Choice" option! To become a Graduate Specialist, you must pass certain qualification and aptitude exams—and be a high school graduate. But high school seniors can take advantage of a special "Early Choice" option to choose from the

widest range of available Graduate Specialist Courses! Under this unusual option, you can apply for the Graduate Specialist program *during the 60 days prior to your graduation . . . before* quotas for the most popular courses are filled. If you qualify, your chosen course will be *reserved* for you until you graduate!

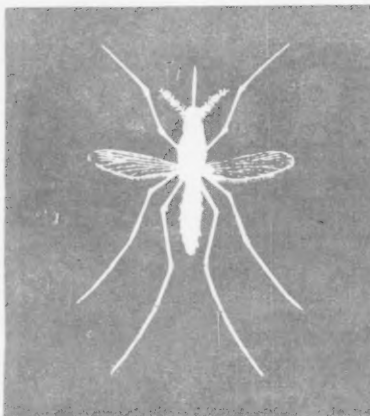
Your course guaranteed BEFORE you enlist . . . without obligation! When you're accepted as a Graduate Specialist, you receive a letter automatically enrolling you in the course of your choice . . . when and if you decide to enlist. Remember! Both high school seniors and graduates go through the entire Graduate Specialist application procedure *without the slightest obligation to enlist!* That means you *get* the course you want—guaranteed in writing—or you *don't* enlist!

Don't miss out! Graduate Specialist appointments in each course are *limited*. This week, get all the details from your Army recruiter.

YOUNG WOMEN . . . As a Graduate Specialist in the Women's Army Corps, you'll have an opportunity to choose from 26 special training courses! For all the facts, contact your local Army recruiter now.

GET CHOICE, NOT CHANCE . . .

Graduate Specialist, United States Army



For the United States the threat of jungle yellow fever lies in the fact that 13 of our southeastern states are infested with *Aedes aegypti*. If human travelers contract yellow fever in the forests of South America and the virus incubates in their blood on the way north, it would be present in concentration high enough to infect any *aegypti* mosquitoes that bit these persons. Spread of the disease would then be rapid. Southern U.S. states will be safe only when they eradicate their *aegypti*.

— The Editors

Stranger than fiction

By Murray Morgan

The case of the silent howlers

Jungle yellow fever had been pinned down and studied,

but it was still moving northward — toward cities that had not exterminated *Aedes aegypti*

CONCLUSION ■ In March, 1950, not long after the appearance of yellow fever northwest of the canal, Colonel Norman Elton, the Army's tropical-disease specialist in the Canal Zone, met the Consul General of Costa Rica at a party and discussed with him the probable course of the disease. After the party, the Consul General wrote to warn his government that the wave of yellow fever was not likely to break before reaching Costa Rica. There was nothing in Panama to stop it. The tropic forest stretched invitingly up the coast; blood tests showed the monkey population highly susceptible to the disease. All that health authorities could do was see that the people were vaccinated and that no *aegypti* were left in the cities to start an urban epidemic, and ask jungle workers to let them know when the howlers stopped braying. The wave, said the Consul General, would probably reach Costa Rica between June and November of 1951.

This proved a good but slightly conservative guess. In April, an employee

of a subsidiary of the United Fruit Company at Almirante, near the Costa Rican border, died of yellow fever. The wave had reached the frontier slightly ahead of schedule. It kept moving north at a steady rate, through the low-lying jungles of Costa Rica toward Nicaragua.

The forests on the Atlantic side of Costa Rica, like those in Nicaragua, are quite uniform. The speed of the virus's advance was so steady, eleven to twelve miles a month, that the epidemiologists were able to move like surfboard riders with the crest of the wave. So well did they have its advance measured that they predicted within a week the time when yellow fever would enter Nicaragua: July of 1952. Honduras was next.

The crest of the wave approached the border of Honduras in the summer of 1953 and broke across, exactly as predicted, in December. The experts had some reason to feel smug at the accuracy of their guesses. But in Honduras everything was changed. Not only were they unable to predict the

course of the virus as it spread through the monkeys; the experts weren't sure afterward what had happened.

In Honduras the coastal mountains are more broken, the jungle patchier, and there was a drought. The *Cebus* monkeys disappeared, though there were still spider monkeys and howlers. The transmitting insects changed, too. *Spegazzinii* died out in the Lancetilla forest. So, when the advance of yellow fever halted in northern Honduras for more than a year, most of the experts felt the wave had spent itself. Then, after a period of eighteen months in which the virus was undetected, monkeys began dying in the same area where the virus had earlier become inactive.

"This was almost unheard of," said Dr. Boshell long afterward. "Usually, the yellow-fever epidemic among monkeys develops immunity in those it does not kill. But that is because *spegazzinii* is such an efficient transmitter. Our studies indicated that we had not thought enough about the role of *Haemagogus equinus* as a vec-

Copyright © 1958 by Murray Morgan. Abridged from one chapter in the book, *Doctors to the World*, which was written by Murray

Morgan and published by The Viking Press, Inc.



URBAN YELLOW FEVER can be wiped out by eradicating *Aedes aegypti*. One means: spraying with DDT (above left). Jungle yellow fever cannot be wiped out, but those exposed to it can be protected by vaccine (below left), and research on the life cycle of its vectors continues with capture of mosquitoes (above right) and laboratory studies.

— Photos courtesy Pan American Sanitary Bureau

tor. It is quite inefficient and, from our point of view, more dangerous, since it does not wipe out the monkey population but encourages a slow, sporadic, undetected, and all but undetectable spread of the disease, which, like a fire smoldering in a log, may later flare up."

In December, 1954, with the virus front still in northern Honduras, Dr. Soper, as director of PASB, called a conference of forty leading yellow-fever experts, at which they talked informally for two days about what was happening in Central America and what might develop. One question was whether yellow fever would continue to move northward toward the big population centers of Mexico and the southern United States, where still exist, uneradicated, *Aedes aegypti* in large numbers, ready to touch off an urban cycle. Most of the experts hedged when asked to guess how far north the disease might travel. Only Colonel Elton, whose guess had been so good on the time the virus would reach Costa Rica, would make a flat prediction.

The colonel declared that his reading of ancient Mayan chronicles convinced him that the Americas were experiencing the first wave of pure jungle yellow fever since the early explorers had introduced the *Aedes aegypti* to the New World. Based on what he could trace of the pre-Conquest epidemics, Colonel Elton predicted that there would be "an epidemic outbreak in northern Guatemala about July, 1955," and that the disease would cross the border into Mexico in 1957.

"I would say," he added, "that on the basis of a calculated risk the wave may be expected to go on into the lowlands of Mexico — the Tierra Caliente of New Spain — which history indicates has been such a fertile hunting ground for the virus in the past centuries."

Jungle yellow fever is hard on monkeys, deadly to occasional forest workers, and inconvenient to large numbers of persons. Its real threat, however, lies in the possibility that it may spread to those cities that have failed

to suppress their *Aedes aegypti*, such as Veracruz and New Orleans. There are those who believe the threat can be met by vaccination. Fred Soper is not among them. He believes that *Aedes aegypti* must be destroyed. Dr. Boshell agrees. He says, "It is difficult to keep a disease under control forever. The practical solution is eradication. We can't rely on the probability that the disease will not reach the cities. Where so many lives are at stake, we must act not in terms of the probable but of the possible."

Twice in recent years the fever has reached into the hearts of large cities. One was Caracas, Venezuela. An Italian engineer working on a road near the seaport town of Barcelona went into the jungle and was inoculated by a mosquito. Returning to Caracas, he came down with yellow fever.

"Fortunately," said Dr. Boshell, "the doctor recognized his symptoms at once and alerted the Health Service. They took a mosquito check in the area where he lived. There was a 25 per cent incidence of *aegypti*; one

Check your choice, clip coupon, and mail to: **Yours for the Asking,**
Science World, 575 Madison Avenue, New York 22, N. Y.

- ☐ 1291 What is a Biologist? ☐ 1292 The Atom in Our Hands
☐ 1293 The Microscopic World of the Molds

See also: page 2

NAME _____
ADDRESS _____
CITY _____ ZONE _____ STATE _____
PLEASE PRINT

Yours for the asking

The Upjohn Company has published a four-page illustrated folder that describes the vital contributions biologists can make to a large pharmaceutical company. *What Is a Biologist?* discusses career possibilities in more than ten of the biological sciences. Check No. 1291.

The Atom in Our Hands (Union Carbide Corporation) gives students a two-part picture of the atomic energy industry. The booklet presents a thorough discussion of (1) radioactive-

atom production at the Government's Oak Ridge National Laboratory — including recent experiments and the training program at Oak Ridge Institute of Nuclear Studies; and (2) how the atom serves industry and medicine. Check No. 1292.

The Microscopic World of the Molds, published by Chas. Pfizer & Co., Inc., is a full-color chart illustrating the micro-organisms from which we produce antibiotics and industrial and agricultural chemicals. No. 1293.

house in four had in it mosquitoes that could carry the disease. The health people simply flooded the town with DDT. It dripped DDT. They were drowning mosquitoes in it. From the apartment, they worked outward in concentric circles, and they shut off *aegypti* from that patient very effectively. It was a quick stop.

"But how many doctors in Venezuela, or Mexico, or the United States would have diagnosed yellow fever? Most have no experience with it.

"As long as we have *Aedes aegypti* our cities are in danger."

On the second occasion in recent years when jungle fever reached into an American city, the health authorities also had extraordinarily good luck in spotting the disease before the epidemic could spread. That was in Port of Spain, Trinidad.

There had been five cases of jungle yellow fever. Then, on August 8, 1954, a case of undiagnosed fever was seen by Dr. Wilbur Downs (director of the Rockefeller research team on Trinidad) in Port of Spain, the capital city. Suspicion of yellow fever did not run high, but the routine blood checks were made. The virus of yellow fever was isolated from the patient's blood. The man had not been to a jungle

area for weeks. This, then, was urban yellow fever. For the first time in a quarter-century, yellow fever had invaded a maritime port in the Americas.

No secondary cases stemming from this infection, or any of the cases leading up to it, were traced. (Anti-mosquito work had started in Port of Spain before the urban case was found, and, fortunately, spraying was under way in exactly the area where the man lived.) Later a second isolated urban case was found.

Trinidad paid a high price for not having eradicated *aegypti* in its cities. The island was listed by the World Health Organization Epidemiological Reporting Service as an infected port. Tourists stayed away by the thousands. Ships and planes were diverted to other ports. The financial loss to the colony was estimated at more than twenty-five million dollars.

During the emergency, war to the death was declared on the *aegypti*. With PASB assistance, the Trinidad Health Department started a campaign to eliminate the mosquitoes by attacking the places where they breed. Patrols scouted the urban areas, looking for signs of *aegypti*. They checked cisterns, flower pots in cemeteries, piles of old tires, water drums, tin cans, coconut shells, and rain gutters. They

found the larvae of *aegypti* in holy-water fonts in churches, in a sponge for wetting stamps in a post office, in distilled water for batteries in a garage, in the water hole of a library paste pot. Wherever mosquitoes might breed they sprayed the surface with DDT or benzene hexachloride. Steadily the incidence of *aegypti* fell. Eradication was the goal this time.

Eradication of *Aedes aegypti*, vaccination of all people exposed to jungle yellow fever, continuing study of jungle yellow fever — these are the steps that must be taken if yellow fever is to be brought under control. Wiping out *Aedes aegypti* will protect the towns and cities of the Americas against yellow fever. It's impossible, of course, to wipe out all jungle mosquitoes. But vaccination can protect those who live near or work in jungles. The international health advisers are helping various national governments in co-ordinated campaigns to vaccinate everyone who may be exposed to the disease. The 17D vaccine is eagerly sought by those who live in areas threatened by yellow fever. And it is made available free through the Carlos Finlay Institute in Bogotá, whose work is backed by the Pan American Sanitary Bureau.

Control is within our grasp. But the men who one day accomplish this aim will owe much to the past.

At the Carlos Finlay Institute I saw an old refrigerator, such as one might find in a farmhouse kitchen. It was filled with hundreds of small glass tubes of vaccine — the armor of a continent. Looking at it, I thought of the people of many nations who had combined to make this wonder possible: of Asibi, who gave his blood, and John D. Rockefeller, who gave his money; of Carlos Finlay, who guessed correctly about the *aegypti* and was ignored, then honored; of the volunteers, American and Cuban, in the experimental cottages run by Walter Reed in Havana; of the scientists like Dr. Boshell who used the dangerous jungle as their laboratory and sometimes died; of the men who drained the swamps of Cuba and Panama and sprayed the cities of a continent; of the thinkers in quiet laboratories. I thought of Fred Soper preaching that *Aedes aegypti* must be eradicated; of the people who conceived and staff the World Health Organization; of the thousands of men and women who administer shots, study slides, take livers from corpses, hunt larvae, minister to the sick, and guard the healthy. There is much to be said for a world in which so many dedicate themselves to helping others.

On the light side

Brain teasers

Asteroidal coincidence

A certain asteroid (one of the many hundreds of tiny planets that circle the sun in orbits between Mars and Jupiter) is perfectly spherical. The number of square miles on its surface exactly equals the number of cubic miles in its volume. What is its diameter?

The Scotchman's scale

A Scotchman wishes to weigh to the nearest pound any object from one to forty pounds. What is the smallest number of weights he must buy for use on his balance scale?

$$\begin{array}{r}
 23 \times 17 \\
 11 \quad 34 \\
 5 \quad 68 \\
 \hline
 2 \quad 136 \\
 1 \quad 272 \\
 \hline
 391
 \end{array}$$

Crazy multiplication

There are many methods of multiplying numbers of more than one digit. Here is one of the strangest.

Suppose you wish to multiply 23 by 17. Half of 23 is $11\frac{1}{2}$. Ignore the fraction, and put 11 under 23 as shown. Half of 11 is $5\frac{1}{2}$. Again ignore the fraction, and put down 5. In short, form a column of successive divisions by 2, omitting all remainders. Continue until you reach 1.

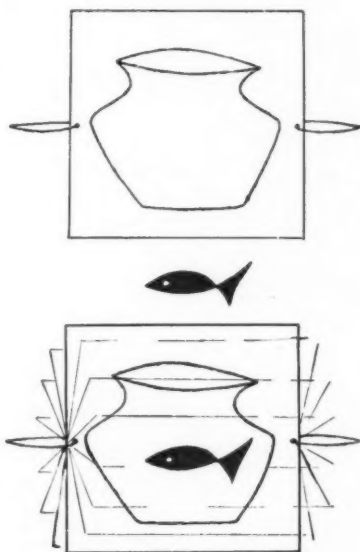
Form a corresponding column under 17. But this time double each number to obtain the one below. Continue until you have a number opposite the 1 in the left-hand column. Draw a line through any row (in this case there is only one) that has an even number on the left. Now add the numbers remaining in the right-hand column. Believe it or not, the answer will be the product of 23 and 17. The method is based on the binary number system and works with any pair of numbers, no matter how large.

Why it works is too complicated to detail here. But if you are interested, you will find it clearly explained in chapter 3 of Helen Merrill's *Mathematical Excursions* (recently reissued as a paperback by Dover Publications).

Twirl a thaumatrope

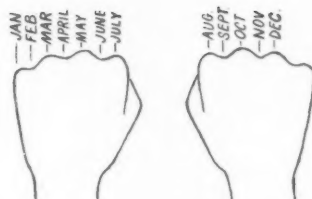
A thaumatrope is a toy device for demonstrating "retinal retention." This is the ability of the eye's retina to retain an image for a split second after the source of the image is withdrawn. A thaumatrope can be made as follows:

Cut out a square piece of cardboard, each edge of which measures about $1\frac{1}{2}$ inches. Punch a hole near each of two opposite edges. Then attach short pieces of cord as shown. Draw a large fishbowl on one side of the square and a small fish on the other side. Hold a string between the thumb and first finger of each hand. By sliding the thumbs over the fingers, you can twirl the square rapidly. While it is twirling, you will see a composite picture of the fish inside the bowl.



Mnemonic aids

Hard-to-remember bits of information can often be stored in the memory by using mnemonic (memory) aids. Here are several examples of how it can be done:



— Drawings by LoCurcio

Which side of a ship or airplane is the port side? You can remember that it is the left side, as you face forward, because "left" and "port" have the same number of letters. Is the port light red or green? Red, because port wine is red. Are stalactites or stalagmites found at the tops of caves? Stalactites, because they stick tight to cavern ceilings.

Mathematicians sometimes remember pi to seven decimal places by recalling the sentence, "May I have a large container of coffee?" The number of letters in each word stands for a corresponding digit of pi.

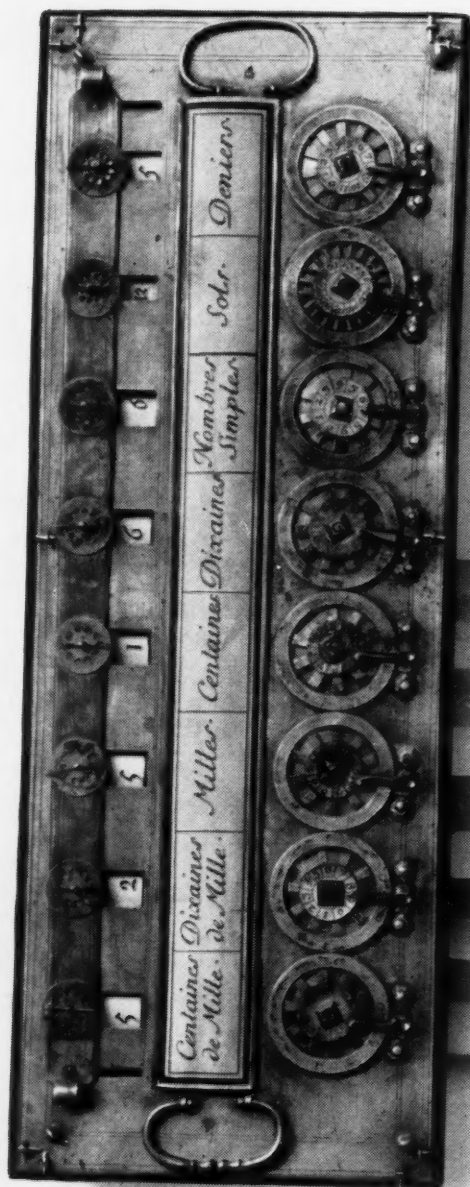
The illustration above shows how your fists may be used for remembering the number of days in each month. Mentally label the knuckles and the spaces between them, from left to right, with the names of the months in proper order. All knuckle months have 31 days. The others have 30, except February. It has 28 days, except in leap years, when it has 29.

— GEORGE GROTH

Answers

ASTEROIDAL COINCIDENCE: The surface area of a sphere is equal to four pi times the square of the radius. Its volume is $\frac{4}{3}$ pi times the cube of the radius. In this case, the two formulas form the two sides of an equation: $4\pi r^2 = \frac{4}{3}\pi r^3$. Dividing each side by πr^2 leaves the equation: $4/3r = 1$. Solving for r , we get a radius of 3, making the diameter 6 miles.

SCOTCHMAN'S SCALE: Four weights (of one, three, nine, and twenty-seven pounds) will do the trick. By placing them on both sides of the scale when necessary, any object from one to forty pounds can be weighed.



The world's first mechanical calculator was born of a teen-ager's restless ingenuity, three centuries ago. To escape the drudgery of adding columns of figures in his father's tax office in Rouen, France, brilliant mathematician Blaise Pascal built a calculating machine that worked. Today, advanced counterparts of Pascal's invention perform repetitive, time-consuming arithmetic tasks in office, plant, laboratory. Freed from the burden of routine computation, man has put mathematics to work in a thousand ways, building a richer life, exploring the mysteries of the physical world.

IBM.

INTERNATIONAL BUSINESS MACHINES CORPORATION

How to do it

Studies in osmosis and diffusion

Topic 1: *How do substances pass into and out of a living cell?*

The osmosis demonstration in which inverted thistle tubes are used is well known. However, the transfer in student-thinking — from the thistle-tube demonstration to osmosis through a cell membrane — is somewhat difficult.

The transfer-in-thinking is made easier by the following demonstration:

Cut three 3-inch lengths of sausage casing. Tie one end of each tight enough to make it leakproof, leaving about 6 inches of string for suspension (see diagram). In effect, you will have made three sacs. Fill two of them with tapwater (call these sacs *W1* and *W2*). Fill the third with a concentrated solution of table salt (call this sac *S*). Tie the open end of each to make it leakproof, again leaving a 6-inch length of string for suspension. Wash the outsides of the filled sacs thoroughly under the tap, for they must be free of any trace of salt. Now suspend each sac from a ring-stand and immerse the sacs in beakers as follows: *W1* in a beaker of tapwater; *W2* in a beaker containing a strong solution of table salt; and *S* in a beaker containing tapwater. The class observes that the filled casings are about the same in size. The entire set-up is left to stand overnight.

Here is a homework assignment given on the day this demonstration is set up: Sometime before you go to bed, place three prunes or raisins (or *both*) in half a glass of water. Dissolve a tablespoon of salt in half a glass of water. Place three other prunes or raisins (or *both*) in it. The next morning, observe and record any changes you see in the prunes or raisins and any change you observe in the water. Make a diagram of any changes you see, and bring your observations to report to the class tomorrow.

The following day, the class observes that *W1* in the demonstra-

tion is unchanged, that *W2* has shriveled, and that *S* is greatly inflated. The students report their homework observations and compare them with those made in the demonstration. The ensuing discussion will raise questions concerning the passage of water and salt through the membranes. To demonstrate that salt has indeed passed from sac *S* into the tapwater of its beaker, remove some water from the beaker in a clean test tube and add a few drops of silver nitrate. A white precipitate indicates the presence of salt.

The same demonstration can be set up using molasses or Karo syrup in place of salt, and Benedict's solution in place of silver nitrate as the reagent to test for the presence of the solute.

For the third day, a laboratory lesson might be planned to let students observe one or more of the following phenomena: plasmolysis of onion skin cells and/or crenation of red blood corpuscles under the influence of salt solutions; cytolysis of red blood corpuscles under the influence of distilled water.

Topic 2: *Which of the nutrients pass through a membrane?*

This topic might be used to introduce the study of the digestive system (presumably, the class has already learned the nutrients and how they may be detected).

Convert two 4- to 5-inch lengths of sausage casing into sacs for sus-

pension as described under Topic 1. Into one sac (call it *N*) introduce water, starch, salt, a monosaccharide such as glucose or dextrose, some oil such as cottonseed oil, some protein such as casein, and a ground-up vitamin C pill. Fill a comparable sac (call it *W*) with water. This is to serve as a control. Prepare two beakers of tapwater. Have students come up and simultaneously (to save time) run nutrient tests on the water in the two beakers. The composite report, recorded on the blackboard, might look like this:

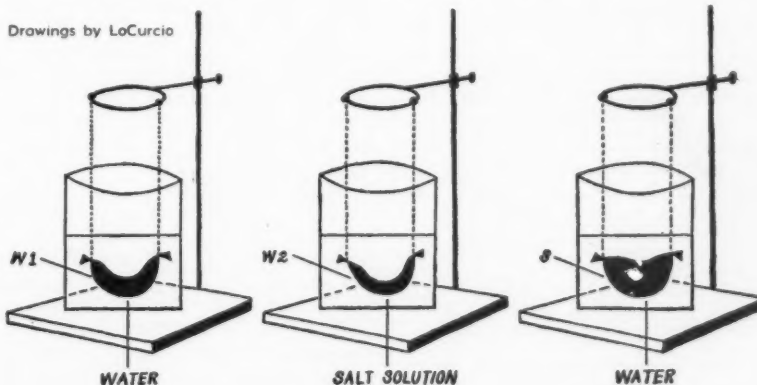
Beaker N	Beaker W
starch:	starch:
sugar:	sugar:
protein:	protein:
fat:	fat:
vitamin C:	vitamin C:
salt:	salt:

Leave this tabulation on the board for the next day. Now suspend each sac in its beaker of water and put away until the next day. On the following day, have students come up and again simultaneously run nutrient tests on the water in the two beakers. Have the results tabulated on the board. The report might look like this:

Beaker N	Beaker W
starch:	starch:
sugar: +	sugar:
protein:	protein:
fat:	fat:
vitamin C: +	vitamin C:
salt: +	salt:

The class observes and compares the data for the two days and discusses the implications.

(Note: sacs are sold as cellophane dialysis tubing.)



Research beyond polio

What teachers should know about the expansion of research
under the auspices of The National Foundation

By Thomas M. Rivers, M.D. Vice President, Medical Affairs, The National Foundation

■ Scientific research in a wide field of medicine will be at the heart of the expanded program announced by The National Foundation,* the voluntary health agency well known for its achievements in combating poliomyelitis. While work in polio continues, new health problems to be attacked initially are arthritis, birth defects (congenital malformations), and disorders of the central nervous system.

In the new disease areas to be tackled, the situation is much the same as existed in poliomyelitis twenty-one years ago when The National Foundation came into being. A considerable amount of knowledge about polio had to be established before an effective vaccine could be developed. This knowledge was acquired by a series of scientists working under March of Dimes grants for a period of years.

Today there are many unknowns about arthritis and birth defects that can be resolved only by a great deal more basic research. Yet results may come faster than in the polio struggle because of what has been learned about research methods. The methods that were so successful in solving many polio problems are now to be applied to the greater challenges that lie ahead.

A large part of past successes can be attributed to the judicious selection of scientists for March of Dimes grants. Among them were Dr. John Enders and his associates, Nobel Prize winners, who found that polio virus could be grown in cultures of non-nervous tissue in test tubes. This paved the way for growth of the virus in quantities massive enough for use in a vaccine. Dr. Jonas E. Salk, who developed the polio vaccine, was chosen early in his career as a brilliant young scientist needed in the virus research program.

In fields related to the new National Foundation program, scientists of promise again will be the recipients of March of Dimes support. Two groups

that will join the research team were responsible for discovery of the substance called "the rheumatoid factor" found in the blood of arthritis patients. It is not known whether this factor is a cause or effect of the disease, but the part it plays will be thoroughly investigated.

Except in a few rare kinds of arthritis, no infectious agent has been found, but because arthritis resembles an infectious disease, the search for an agent has not been ruled out.

Many scientists also believe that in arthritis the body defenses called antibodies are at work and that these defenses may themselves cause the trouble. Antibodies are generally thought of as disease-fighters. In polio, it is known that they are effective. Yet in some cases antibodies themselves can cause illness. Arthritis may be such a case. This is another lead that will be pursued in the research plan.

Portions of the research program will grow out of projects The National Foundation has supported so far. Studies in the virus field are already leading far beyond polio and are even producing information useful in the fight against diseases not caused by viruses. It is proposed to follow these clues wherever they may lead.

In the course of investigation on polio, numerous previously unknown viruses have been discovered. Some of these can cause paralysis, but the effect of most is imperfectly known. It has been suggested that some of these agents may attack during childhood, causing mild disease or no symptoms at all but leaving lesions in the nervous system that may cause illness under stresses in later life. This also demands further study.

Congenital malformations can be caused by a virus attacking the mother and fetus during pregnancy. This is known to be the case with German measles, but it has also been suggested that some of the recently discovered viruses may be responsible in certain instances. There is evidence that a virus invasion that may not cause ill-

ness in the mother may nevertheless damage her unborn child. Research in this area should produce much information on what viruses are responsible and may lead to protection against their attack.

Certain birth defects are known to be frequently transmitted from parents to children, but little is known regarding the laws by which such defects are passed on to succeeding generations. Scientists now believe that nucleic acid in the cell is the basic factor of heredity. If the nucleic acid in a cell destined to be a human being is defective, the result is apt to be a defective infant. Even in a mature human being, there is evidence that something abnormal in the nucleic acid is related to cancer.

In polio, work is moving forward on studies of the metabolism of living cells. Much more can be learned about how cells grow and about the mechanisms involved when viruses attack cells and take control of them. A thorough understanding of these processes will give a key to better understanding of many diseases.

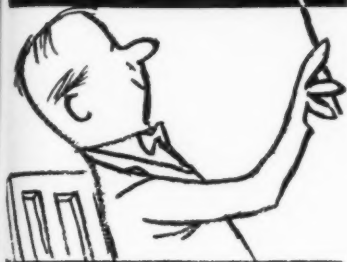
National Foundation grantees also are searching for drugs. Hundreds of chemical compounds have been tested for their effectiveness against polio and other virus diseases. Already some drugs give hope, although they are not yet suitable for human trials. Drugs for the treatment of arthritis may constitute an important field for investigation by Foundation grantees.

These are only some of the investigations now under way or projected. Efforts to bring the Salk vaccine as near as possible to perfection will be continued, and studies of other types of vaccine are in progress. Through research, rehabilitation and treatment techniques are constantly improved, salvaging the lives of severely disabled polio patients once thought hopeless.

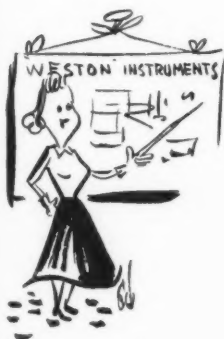
With the support of the public, through the March of Dimes, this research program may bring victories more brilliant than the achievements in polio.

*Originally the National Foundation for Infantile Paralysis, Inc.

TEACHER'S TOOLS



WESTON INSTRUMENTS, Division of Daystrom, Inc., offers bulletin-board-size (21" x 27") multicolored teaching charts to teachers without charge. The expertly done visual aids illustrate Weston Instrument Mechanisms, including voltmeter, wattmeter and ammeter. Also available: some dozen or more Weston circulars dealing with everything from tube checkers to student galvanometers. (For Weston teaching charts and circulars, check No. 129A.)



"PLANET EARTH," available from the National Academy of Sciences, is a new and thoroughly vital teaching aid with three principal components. They include a set of six posters in full color, a project leader's kit, and student brochures. Large size (34" x 48") and in full color, the posters are artistic as well as educational. Illustrated suggestions for their effective display in

the classroom, auditorium, corridor or library are provided with each set. Prepared by the staff of the U.S. National Committee for IGY, "Planet Earth" should be ordered directly from the NAS Publications Office, 2101 Constitution Avenue N.W., Washington 25, D.C. The cost of the recommended classroom package including 30 student-brochure copies is \$9.50. (Note: Do not use coupon to order this.)

CENTRAL SCIENTIFIC COMPANY meets nuclear-age teaching demands with its Cenco Radioactivity Demonstrator. Using this instrument, teachers and students can carry out interesting and informative demonstrations and experiments in radioactivity, radiation intensity, absorption, tracer-element detection, scattering, and health hazards. Portable, the unit is ideal for the classroom, since it provides triple indication of radioactivity by loud-speaker, flashing light, and built-in count-rate meter. This is just one of a thousand and more teaching aids in the new Cenco 1959 Order Book, available to science teachers upon request. (Check No. 129B for your copy of the Cenco 1959 Order Book.)

ARTHUR S. LAPINE AND COMPANY features a new Lanco polyethylene sink trap that has many advantages over former plastic sink traps. Besides having all junctions visible to the outside, the new trap comes with a 1 1/2" NPS pipe on the outlet union, accommodating insert adapters for connection to standard-size polyethylene pipe. Maintenance is reduced to practically nothing with these traps since they are simply unscrewed by hand. The traps are resistant to acids, bases, mercury, and other reagents. (For fur-

ther information on Lanco traps and a complete line of teaching apparatus and furniture, check No. 129C.)



DOERR GLASS COMPANY will save your expendable-item budget many dollars through its concise and well-written booklet, "Facts about the Economics of Laboratory Glassware." The booklet stresses the fact that proper selection of laboratory glassware in terms of the job it is intended to do is the only real answer to economical buying. (If economy is a factor in your classroom operation, check No. 129D for your copy of this interesting little booklet.)

Modern reference and textbook 'tools'

A Sourcebook for the Biological Sciences, by Evelyn Morholt, Paul F. Brandwein, and Alexander Joseph. 1958. Harcourt, Brace and Co., 383 Madison Ave., New York, N. Y.

Elements of Physics, revised by Paul J. Boylan, Roxbury Memorial High School, Boston, 1958. Allyn and Bacon, Inc., 41 Mt. Vernon St., Boston, Mass.

Basic Aeronautical Science and Principles of Flight, by Robert D. Blacker, 1958. American Technical Society, 848 E. 58th St., Chicago 37, Ill.

Check your choices, clip this coupon, and mail to
Science Teacher's World, Dept. TT
575 Madison Ave., New York 22, N. Y.

<input type="checkbox"/> 129A	<input type="checkbox"/> 129B	<input type="checkbox"/> 129C	<input type="checkbox"/> 129D
NAME _____			
SCHOOL _____			
ADDRESS _____			
CITY _____		ZONE _____	STATE _____
PLEASE PRINT			

Shop talk

Glamorized graphing

A "classroom tested" device to glamorize graphing is suggested by John Wagner, Consultant in Science-Mathematics Education, Extension Teaching Service, University of Texas.

He points out that a simple piece of pegboard with co-ordinate axes permanently painted on it serves as an effective classroom aid. "The point of the plot," he writes, "can be described with brightly colored plastic golf tees. If it is necessary to connect the points of the plot, colored rubber bands serve admirably. The various colors of the golf tees offer the added advantage of being able to show different relations and functions simultaneously.

"At the same time, class members can use individual squares of acoustical wall and ceiling board having regularly spaced perforations. Again, golf tees can be used for showing points that have been plotted. There's a saving in teacher time in that the teacher can have students show their work from any part of the classroom. The brightness of the golf tees makes the work show up."

We hope you'll consider "Shop Talk" a combination teachers' room, seminar, and conference round table — a meeting place where all good science teachers can come to the aid of one another by speaking their minds and sharing their experiences. Won't you send us news of unusual classroom experiments, problems, and/or triumphs?

Payments of twenty-five dollars will be made to contributors whose material is used in "Shop Talk." The editors regret that they cannot acknowledge or return unused contributions.

Please send your contributions to this address: Science World Shop Talk, 575 Madison Avenue, New York 22, N. Y.

Chemiluminescent material

Would you like to have a mixture to replace the two or more solutions usually required for chemiluminescence demonstrations? Such a mixture, called "Chemilite (blue)," is being offered to science teachers at cost by the Shawe Science Club of Shawe Memorial High School in Madison, Indiana.

When the mixture is added to water and stirred, "cold light" can be seen in a darkened room. According to Theodore A. Winkel, club sponsor, this experiment has advantages over the usual iron-and-sulfur experiments illustrating the exothermic reaction. But he thinks it should be used to supplement rather than replace that experiment.

To get a packet of fifteen grams, send fifteen cents (in coin) to the Shawe Science Club, along with a request on your school letterhead.

Teacher's Question box

What is an accumulator plant? — P. J. M., Albany, N. Y.

According to Dr. T. S. Lovering of the U. S. Geological Survey, an accumulator plant is one that takes up certain specific elements to a much greater degree than do most plants. There are plants that accumulate selenium, molybdenum, aluminum, iron, or silica. Among silica-accumulators are horsetails, bamboo, palm trees, and several kinds of grasses.

What can I use as an inexpensive indicator of acids and bases? — S. S. R., San Francisco, Calif.

Boil some purple cabbage leaves. The coloring will dissolve in the water. Allow the water to cool, and filter out the cabbage leaves by pouring the water through several layers of cheesecloth or filter paper. You will find, on testing, that the liquid will turn red in acid and blue in alkali.

At extremely low temperatures, metals have been known to become super-conductors of electricity. Does the same hold for high pressures? — D. M., New York, N. Y.

Dr. H. Tracy Hall, Director of Research at Brigham Young University, reports as follows (*Science*, August 29, 1958): "Pressures of 100,000 atmospheres increase the electrical conductivity of most metals by about 20 per cent. However, the conductivity of some metals is increased by as much as 400 per cent. This phenomenon, of course, is in accord with the general fact that high pressure behaves similarly to low temperature."

Gold key requests

Are you planning any kind of awards-recognition at the end of the first semester? If so, now is the time to enter your request for the gold keys inscribed with the word "Science" that SCIENCE WORLD offers its teacher subscribers. These keys and their accompanying certificates are available ON REQUEST only. They should be requested according to this scale:

Student orders	Keys
10-100	1
101-200	2
201-300	3

and so on, for as many copies as you have ordered.

The keys may be awarded at your discretion to whichever student you wish to encourage with special recognition. Teachers who request keys at the end of the first semester may also request them at the end of the second semester.



Al-

Geo-
takes
egree
ulate
ilica
boo,

or of
Calif.
will
and
water
aper.
n red

have
elec-
ures?

gham
ugust
crease
ut 20
tals is
homet
t that
ture."

ion at
me to
with
ers its
pany-
They

1